Five-Year Review Report

First Five-Year Review Report
For
Geigy Chemical Corp. (Aberdeen Plant)
Aberdeen
Moore County, North Carolina

September 2003

Prepared By:

US Army Corps of Engineers
Wilmington District
Wilmington, North Carolina

Prepared For:

Region 4
U.S. Environmental Protection Agency
Atlanta, Georgia

Five-Year Review Report

Table of Contents

List of Figures

List of Tables

List of Acronyms

AOC	Administrative Order on Consent
ARARs	Applicable or Relevant and Appropriate Requirements
BHC	Benzene Hexachloride
CENWO-HX-G	Corps of Engineers Hazardous, Toxic and Radioactive Waste Center of Expertise
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CESAW-TS-PE	Wilmington District, Corps of Engineers Environmental Resources Section
CFR	Code of Federal Regulations
CRQL	Contract Required Quantitation Limit
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
EPA	United States Environmental Protection Agency
FS	Feasibility Study
HRS	Hazard Ranking System
IAG	Interagency Agreement
Kg	Kilogram
L	Liter
Mg	Milligram
NCGWQS	North Carolina Groundwater Quality Standards
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
ppb	Parts Per Billion
ppm	Parts Per Million
PRP	Potentially Responsible Party
RA	Remedial Action
RD	Remedial Design
RI	Remedial Investigation
ROD	Record of Decision
RPM	Remedial Project Manager
SARA	Superfund Amendments and Reauthorization Act of 1986
TCE	Trichloroethene
TCL	Target Compound List
µg	Microgram
USACE	United States Army Corps of Engineers
WasteLAN	The Regional database related to CERCLIS

Executive Summary

This report documents the first five-year policy review of the National Priorities List (NPL) site NCD981023260. The site, referred to as Geigy Chemical Corp. (Aberdeen Plant), is a former pesticide formulation and retail sales site located in Aberdeen, Moore County, North Carolina. The site is approximately one acre in size. Contaminants of concern originally associated with groundwater at the site are pesticides including aldrin, BHC isomers, dieldrin, endrin, toxaphene, and the solvent trichloroethene (TCE). Subsequent investigations showed that trichloroethene contamination was not a result of site activities and was therefore removed from the Site Target Contaminants List (TCL). There was also soil contamination involving the same pesticides listed for groundwater and the additional compounds, DDD, DDE, DDT, and chlordane isomers. These contaminants are the result of use of the site for pesticide formulation and blending and agricultural chemical sales from 1947 to 1989.

In March 1988, an EPA Site Investigation in support of the Hazard Ranking System (HRS) was conducted on the site. Isomers of BHC were found in groundwater samples from three municipal and two private wells. Based on the results of the site investigation, the site was proposed to the National Priorities List (NPL) in June 1988 and listing was finalized October 4, 1989.

There were three removal actions associated with the site for soil remediation. The first two, conducted in 1989 and 1991, removed soils visibly contaminated and other debris from the site. Approximately 3,300 tons of soil and debris were removed for disposal in these two actions. Following the preparation and finalization of a Remedial Investigation/Feasibility Study, a Record of Decision (ROD) was signed August 27, 1992. The Remedial Action implemented by the ROD included demolition of the former warehouse foundation; excavation of the top foot of on-site soils contaminated above performance standards; off-site disposal of excavated soils as appropriate; extraction of groundwater from the surficial and Upper Black Creek aquifers; treatment of extracted groundwater via carbon adsorption; site restoration; and further sampling and analysis of the Upper Black Creek aquifer to determine extent of pesticide contamination and determine if TCE found in two wells was site-related.

The Remedial Action (RA) was implemented from September 1996 to February 1997. The RA included removal of concrete foundations and other debris totaling approximately 2,460 tons to a Subtitle D landfill; disposal of 4,475 tons of contaminated soils to a Subtitle C landfill; construction and installation of extraction wells and groundwater treatment facilities with an infiltration gallery for discharge of treated groundwater. The treatment system began operation in January 1997 and has currently treated approximately 30 million gallons of extracted groundwater from the surficial and Upper Black Creek aquifers.

As required in the ROD, a downgradient investigation was conducted to determine the extent of pesticide plumes in the Upper and Lower Black Creek aquifers. The results of the investigation, reported in the *Downgradient Groundwater Remedial Action Work Plan (RAWP)*, and the recommendations therein, were adopted by EPA through the issuance of the January 1998 Explanation of Significant Difference (ESD). The ESD established that the downgradient groundwater contaminant plume would be monitored as part of the overall site remedy. The

selected remedy for the downgradient area is monitored natural attenuation of the plume with the following contaminant concentration goals: alpha-, beta-, and delta-BHC 0.05 µg/L (micrograms per liter), and gamma-BHC 0.20 µg/L.

There were several issues identified during the review process. None of the issues affect the assessment of the performance of the remedy. However, each should be addressed before the next five-year review. The issues are described as follows:

1. Fencing and signing of the site as proposed in the documents of record have not been accomplished. This proposal was prepared prior to completion of the soil remediation and may no longer be applicable.

2. The Site Groundwater Remediation Permit issued October 1, 1999 and expiring June 30, 2004, needs to be changed to reflect that the treatment facilities consist of seven (7) recovery wells rather than the five (5) listed.

3. Evidence indicates encroachment of the off-site trichloroethene (TCE) contaminant plume into the site treatment area. Increasing TCE levels have shortened the life of carbon adsorption canisters in the treatment facility, however, the long-term effects of this change on the remedy are unknown.

The remedial actions at the Geigy Chemical Corp. (Aberdeen Plant) site currently protect human health and the environment. The soil remediation for the site has been completed, and the pump-and-treat remediation of the groundwater contamination including monitoring is continuing. The trends of contaminant concentrations in groundwater both at the site and in the downgradient area appear to be downward. Performance standards for contaminants of concern are exceeded in the monitoring wells for the area under remedy implementation. To ensure long-term protectiveness of the selected site remedy, continued monitoring and operation of the groundwater treatment facility should continue.

Five-Year Review Summary Form

Five-Year Review Summary Form		
Site Identification		
Site Name: Geigy Chemical Corp. (Aberdeen Plant)		
EPA ID: NCD981927502		
Region: 4	**State:** NC	**City/County:** Aberdeen/Moore
SITE STATUS		
NPL status: ✓ Final ☐ Deleted ☐ Other:		
Remediation Status: ☐ Under Construction ☐ Operating ☐ Complete		
Multiple OUs?* ☐ YES ✓ NO	**Construction Completion Date:** September 27, 2000	
Has site been put into reuse? ☐ YES ✓ NO		
REVIEW STATUS		
Reviewing agency: ✓ EPA ☐ State ☐ Other:		
Author name: Stacy Samuelson		
Author title: Biologist	**Author affiliation:** USACE, Wilmington District	
Review period:** 1/03 – 9/03		
Date(s) of site inspection: February 17, 2003		
Type of review:*** ☐ Statutory ✓ Policy		
Review number: ✓ 1 (first) ☐ 2 (second) ☐ 3 (third) ☐ Other (specify)		
Triggering action:**** ✓ Other (specify) Preliminary Close-Out Report		
Triggering action date: July 20, 1998		
Due date (five years after triggering action date): July 20, 2003		

Five-Year Review Summary Form

Issues:

1. Fencing and signage for the site as proposed in the documents of record have not been implemented.
2. Site Groundwater Remediation Permit needs to be modified to reflect actual number of wells associated with the treatment facility.
3. Encroachment of the off-site trichloroethene (TCE) contaminant plume into the site treatment area.

Recommendations and Follow-up Actions:

1. The need for fencing and signage of the site was negated by removal of the contaminated soils during the remedial action. No action should be taken.
2. The PRPs should update the Site Groundwater Remediation Permit when renewed in 2004.
3. Monitoring of the affect(s) of the TCE plume on the site remedy should continue, with close coordination by all parties.

Protectiveness Statement(s):

The remedy at the Geigy Chemical Corp. (Aberdeen Plant) Site is expected to be or is protective of human health and the environment, and in the interim, exposure pathways that could result in unacceptable risks are being controlled. The next Five-Year Review should be scheduled five years from the date of this Review, in "MONTH" 2008.

Other Comments: None.

* "OU" refers to operable unit.
** Review period should correspond to the actual start and end dates of the five-year review in WasteLAN.
*** See Chapter 1, Section 1.2 of EPA 540-R-01-007, Final June 2001 for further explanation.
**** See Chapter 1, Section 1.3 of EPA 540-R-01-007, Final June 2001 for further explanation.

Approved By: ***Date:*** 9/25/03

Winston A. Smith
Director, Waste Management Division
U.S. EPA Region 4

FIVE-YEAR REVIEW REPORT

I. INTRODUCTION

The United States Environmental Protection Agency (EPA) Region 4 has completed a five-year review of remedial actions implemented at the Geigy Chemical Corp. (Aberdeen Plant) site in Aberdeen, Moore County, North Carolina. The United States Army Corps of Engineers (USACE) conducted and provided technical assistance and analysis for the five-year review. The Environmental Resources Section, Planning and Environmental Branch, Technical Services Division of the Wilmington District, Wilmington, North Carolina provided the USACE lead for this review. The review was accomplished under EPA Work Authorization Form for Interagency Agreement (IAG) Number DW96945884A. The Wilmington District was supported in the conduct of the review by the USACE Hazardous, Toxic and Radioactive Waste Center of Expertise (CENWO-HX-G) located at the Omaha District, Nebraska. This review was conducted from January 2003 through September 2003. The report documents the results of that review.

The purpose of five-year reviews is to determine whether the remedy at a site is or is expected to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in five-year review reports. In addition, five-year review reports identify issues found during the review, if any, and recommendations to address them.

This review is a policy review. EPA must implement five-year reviews consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substance Contingency Plan (NCP). CERCLA § 121(c), as amended states:

> If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often that each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented.

The NCP part 300.430(f)(4)(ii) of the Code of Federal Regulations (CFR) states:

> If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.

Although not required by statute, this review is being conducted in accordance with EPA policy. EPA conducts five-year reviews as a matter of policy at: (1) sites where no hazardous substances will remain above levels that allow unlimited use and unrestricted exposure after completion of remedial actions, but the cleanup levels specified in the Record of Decision (ROD) will require five or more years to attain; (2) sites addressed before Superfund Amendments and Reauthorization Act (SARA) at which the remedy,upon attainment of cleanup levels, does/will not allow unlimited use and unrestricted exposure; and (3) removal-only sites where hazardous substances remain onsite at levels that will not allow unlimited use and

unrestricted exposure. This site has been reviewed because cleanup levels will require more than five years to attain.

This is the first five-year review of the Geigy Chemical Corp. (Aberdeen Plant) site. The Site has been identified as requiring a "policy" five-year review, which must occur within 5 years after completion of construction. Completion of construction, as designated by signature of the Preliminary Close-Out Report occurred on July 20, 1998.

This review will be placed in the EPA site files and local repository for the Geigy Chemical Corp. (Aberdeen Plant) site. The local repository is located at the Aberdeen Town Hall, 115 N. Poplar St., Aberdeen, NC 28315.

II. SITE CHRONOLOGY

Table 1 lists the chronology for selected events for the Geigy Chemical Corp. (Aberdeen Plant) site, as shown below.

Table 1: Chronology of Events

EVENT	DATE
Site leased by several companies for pesticide formulation and retail sales.	1947 to 1989
EPA detected pesticides in surface and subsurface soils on the site.	January 1987
Site inspection conducted by the State.	March 1987
Preliminary site assessment.	June 1987
Hazard Ranking System (HRS) evaluation.	August 1987
Site proposed to be listed on the National Priorities List (NPL).	June 1988
Site added to National Priorities List (NPL).	October 4, 1989
PRPs conducted a soil removal action. 462 tons of soil and debris removed.	February 23, 1989 to December 16, 1989
Administrative Order on Consent issued.	January 23, 1991
Second soil removal action by PRPs. 2,841 tons of soil and debris removed.	February 25, 1991 to June 1, 1991
Human Health Risk Assessment and Ecological Risk Assessment completed.	March 13, 1992
PRP preparation of Remedial Investigation and Feasibility Study (RI/FS).	December 16, 1988 to August 27, 1992
Record of Decision (ROD) signed.	August 27, 1992
Consent Decree for PRPs to conduct remedial design/remedial action (RD/RA)	July 15, 1993
RA contract for construction of groundwater remediation system and removal of contaminated soil and debris awarded by PRPs.	September 1996
Pre-final inspection of soil remediation by EPA and State of North Carolina.	January 15, 1997
Groundwater Remediation System operational.	January 1997
Final inspection of soil remediation by EPA and State of North Carolina.	February 26, 1997
Downgradient Groundwater Remedial Action Work Plan approved by EPA and NC DENR.	November 1997
Explanation of Significant Differences issued by EPA.	January 1998
Preliminary Close-Out Report	July 20, 1998
Additional monitoring well installation.	April 1998
Site inspection for the first five-year review.	February 18, 2003

III. BACKGROUND

A. Physical Characteristics

The Geigy Chemical Corp. (Aberdeen Plant) Site is located just to the east of the corporate limits of Aberdeen, North Carolina in southeastern Moore County (Figure 1). The Site

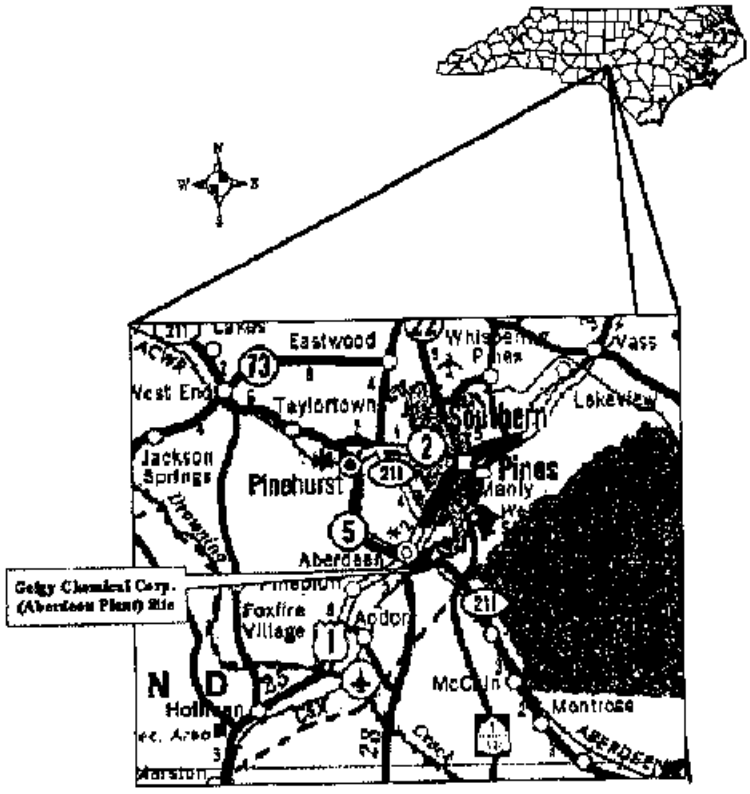
is located on the Aberdeen and Rockfish Railroad right-of-way adjacent to Highway 211 and forms an elongated triangle with the highway and railroad forming the apex.

The Geigy Site encompasses an area of approximately one acre that has been graded to be mostly level in nature (Figure 2). The site has topography typical of the Upper Coastal Plain physiographic region, with shallow water tables and low topographic relief. Soils in the area are classified as the Candor sand type that overlays unconsolidated sandy to clayey sediments. There are also an intermittent clay zone and several other clay lenses that divide the surficial groundwater aquifer from the Upper and Lower Black Creek aquifers in the area. Drainage from the site and predominant groundwater flow is to the west and northwest with both surface and subsurface runoff entering McFarlands Branch, Ray's Mill Creek, and Aberdeen Creek.

B. Land and Resource Use

Current land use of the area is rural residential and commercial in nature. The city of Aberdeen has approximately 3,400 residents. The Moore County area has grown approximately 18% in the last ten years and may continue to do so. Based on current levels of development of the area, it is not foreseen that there will be any major change in land-use in the future.

Figure 1. General Location

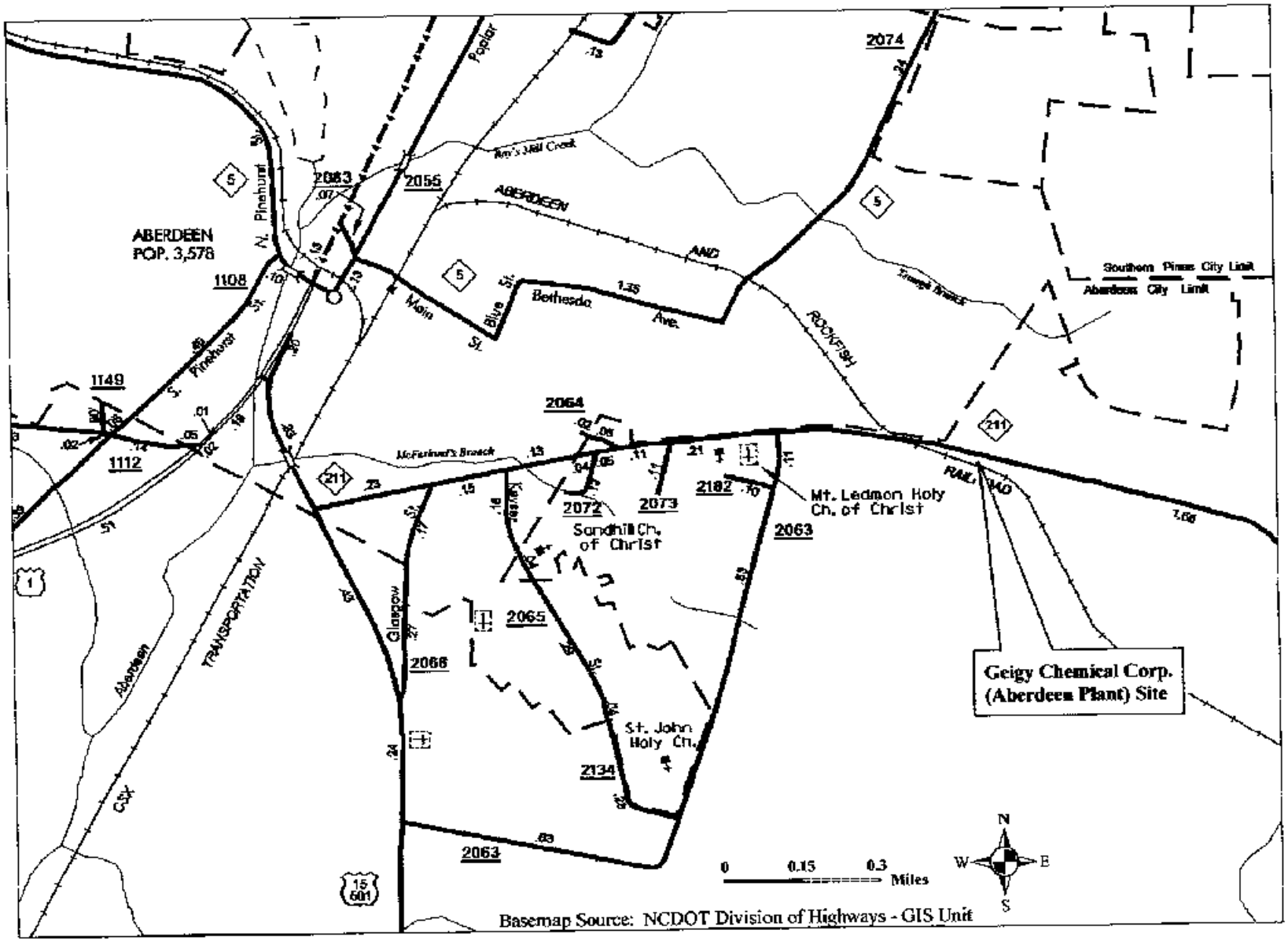


C. History of Contamination

The Geigy Site was leased for the formulation and retail sale of pesticides from 1947 until its closure in 1989. Agricultural fertilizers in bulk and bagged form were also distributed from the site during its operational history. The pesticides DDT, toxaphene, and BHC were formulated for field use on-site by mixing with inert materials such as clay and repackaged for sale in the local agricultural market.

An EPA Site Investigation was conducted in March 1988 in support of the Hazard Ranking System (HRS) evaluation of the site. Isomers of BHC were found in groundwater samples from five locations: three municipal wells and two private wells.

Figure 2. Specific Site Location



D. Initial Response

As discussed briefly in Section C above, the Environmental Protection Agency (EPA) conducted a Site Investigation of the site in March 1988 in support of a Hazard Ranking System (HRS) evaluation.

The site was proposed to be included on the National Priorities List (NPL) in June 1988 and final designation was completed October 4, 1989. During that time, notice letters were sent to six companies: Ciba-Geigy Corp, Olin Corp, Kaiser Aluminum & Chemical Corp, Lebanon Chemical Corp, Aberdeen and Rockfish Railroad, and Columbia Nitrogen Corporation. The notice letters requested that the Potentially Responsible Parties (PRPs) conduct a Remedial Investigation and Feasibility Study (RI/FS) for the site. An Administrative Order on Consent (AOC) was entered into by EPA and three of the PRPs (Ciba Geigy {currently Syngenta Crop Protection, Inc.}, Olin Corp, and Kaiser) for performance of the RI/FS on December 16, 1988.

IV. REMEDIAL ACTIONS

A. Remedy Selection

The remedial actions in the Record of Decision (ROD) dated August 27, 1992, provided for remediation of contaminated soils and groundwater. The remedial actions identified in the ROD were as follows:

Groundwater

The groundwater remedy was targeted at removal of site-related contaminants in the groundwater through groundwater extraction and on-site treatment by chemical means and air stripping. The following activities were identified as being associated with this alternative:

- Contaminated groundwater would be extracted from within the Surficial and Upper Black Creek aquifer plume via extraction well(s) and piped to an on-site, aboveground treatment facility.
- Treatment would consist of carbon adsorption canisters to remove contaminants of concern.
- Final discharge of the effluent would be to either an on-site infiltration gallery or via connection to a Publicly Owned Treatment Works (POTW).
- Continued analytical monitoring of contaminants in groundwater.
- Further characterization of the Upper Black Creek aquifer to determine the extent of pesticide contamination.

Soils

The remedy for contaminated soils had the intent of permanently removing contamination in the soil through off-site disposal of contaminated soils. The following activities were identified as being associated with this alternative:

- Excavation of the top foot of soils exceeding cleanup standards identified in the ROD.
- Disposal of contaminated soils in a secure landfill or a fixed-base incinerator depending on their regulatory requirements.
- Confirmation sampling and analysis to ensure that remediation levels are attained.
- Backfill of excavated areas with clean fill, regrading of site and revegetation with native grasses.

Tables 2 and 3 show the clean-up standards for soil and groundwater under the ROD.

Table 2. Soil Clean-Up Standards

Soil Clean-Up Standards	
Contaminant	**Clean-up Standard** (mg/Kg)
Aldrin	0.113
Alpha-BHC	0.28
Beta-BHC	1.15
Delta-BHC	NC
Gamma-BHC	1.5
Dieldrin	0.13
Endrin Ketone	NC
Toxaphene	2.0
DDD	7.6
DDE	5.5
DDT	4.75
Gamma-Chlordane	1.43
Alpha-Chlordane	1.4

* Note: NC = Not Calculated.

Table 3. Groundwater Clean-Up Standards

Groundwater Clean-Up Standards			
Contaminant	**Groundwater Clean-Up Standard** (µg/L)	**Corresponding Risk Level**	**Basis of Goal**
Aldrin	0.05	5.0×10^{-6}	CRQL
Alpha-BHC	0.05	1.3×10^{-6}	CRQL
Beta-BHC	0.05	4.0×10^{-7}	CRQL
Delta-BHC	0.05	ND	CRQL
Gamma-BHC	0.05	3.0×10^{-7}	CRQL
Dieldrin	0.1	8.3×10^{-6}	CRQL
Endrin Ketone	0.1	ND	CRQL
Toxaphene	1.0	6.7×10^{-6}	NCGWQS

CRQL – Contract Required Quantitation Limit
NCGWQS – North Carolina Groundwater Quality Standards
ND – Not Determined, Toxicity data unavailable, risk levels could not be calculated.

The soils removal remediation was completed in early 1997. Site restoration was conducted in January 1997. A final inspection by EPA and the State of North Carolina Division of Superfund occurred on February 26, 1997.

Based on results of the pre-remedial design field investigation, showing the presence of pesticides in the Upper Black Creek aquifer, additional investigations of the downgradient areas were conducted. A *Downgradient Groundwater Investigation Work Plan* (Rust, 1995) was prepared and presented to the EPA and NCDENHR to determine type, distribution and concentration of pesticides in the downgradient areas. Field investigations for the downgradient groundwater studies were conducted from March to October 1995. Results of the investigation were reported in the *Downgradient Investigation Summary Data Report* dated March 1996.

The PRPs and Agencies met in May of 1996 to discuss preparation of a remedial action plan for the downgradient area and agreed to develop a Remedial Action Work Plan (RAWP) that would evaluate the containment and attenuation of pesticide concentrations as a component of the remedial action for the downgradient area. The resulting RAWP, finalized in November 1997, has the following objectives:

- reduce pesticide concentrations in downgradient groundwater to levels which are protective of human health and the environment;
- ensure that Site-related pesticide concentrations in downgradient surface water and stream sediments are protective of human health and aquatic receptors; and
- monitor drinking water supplies in the downgradient area to verify they are not adversely impacted.

The RAWP defined the downgradient area as the portions of Upper and Lower Black Creek aquifers bounded by McFarland's Branch, Aberdeen Creek, Ray's Mill Creek, and Trough Branch. The surficial aquifer was excluded from the work plan. Data from the downgradient groundwater investigations revealed that the BHC isomers were the only target pesticides exceeding Federal or State drinking water standards or Site Performance Standards. As a result of the analyses, the goal of the downgradient remedial action is to reduce BHC isomer concentrations to levels below the North Carolina and Federal drinking water standards or, for alpha-, beta-, and delta-BHC, which do not have established drinking water standards, to levels below the groundwater Performance Standards listed in Table 3. The downgradient groundwater Performance Standards are listed in Table 4.

Table 4. Downgradient Groundwater Clean-up Standards

Contaminant	Clean-up Standard (µg/L)
Alpha-BHC	0.05
Beta-BHC	0.05
Delta-BHC	0.05
Gamma-BHC	0.20

The recommendations and proposed remedial Performance Standards for the downgradient groundwater in the RAWP were implemented by issuance of an Explanation of Significant Differences to the Remedial Action (ESD) in January of 1998. The different

performance standards for gamma-BHC (Lindane) between the site remedy (0.05 µg/L; Table 3) and the downgradient remedy (0.2 µg/L; Table 4) reflect a change in the North Carolina Groundwater Standards (Title 15A NCAC 2L .0202) between issuance of the ROD and ESD.

B. Remedy Implementation

There were three removal actions associated with the site for soil remediation. The first two, conducted in 1989 and 1991, removed soils visibly contaminated and other debris from the site. Approximately 3,300 tons of soil and debris were removed for disposal in these two actions. The 1989 removal action consisted of two phases. In the February 1989 phase, material removed was disposed of in the GSX landfill in Pinewood, South Carolina. The second phase in October 1989, resulted in soils being incinerated at the ThermalKem facility in Rock Hill, South Carolina or being transported as hazardous waste to the Laidlaw Environmental Services Landfill (Formerly GSX Services) in Pinewood, South Carolina. During the 1991 removal, approximately 500 tons of soil were incinerated at the Rollins Facility in Deer Park, Texas. The remainder of the soil and debris removed were disposed of at the Chemical Waste Management landfill in Carlyss, Louisiana. Following the preparation and finalization of a Remedial Investigation/Feasibility Study, a Record of Decision (ROD) was signed August 27, 1992. The Remedial Action implemented by the ROD included demolition of the former warehouse foundation; excavation of the top foot of on-site soils contaminated above performance standards; off-site disposal of excavated soils as appropriate; extraction of groundwater from the surficial and Upper Black Creek aquifers; treatment of extracted groundwater via carbon adsorption; site restoration; and further sampling and analysis of the Upper Black Creek aquifer to determine extent of pesticide contamination and determine if TCE found in two on-site wells was site-related.

The Remedial Action (RA) was conducted from September 1996 to February 1997. The RA included removal of concrete foundations and other debris totaling approximately 2,460 tons to a Subtitle D landfill in Kernersville, North Carolina; and disposal of 4,475 tons of contaminated soils to a Subtitle C landfill in Pinewood, South Carolina; construction and installation of extraction wells and groundwater treatment facilities with an infiltration gallery for discharge of treated groundwater. The treatment system began operation in January 1997 and has currently treated approximately 30 million gallons of extracted groundwater from the surficial and Upper Black Creek aquifers.

C. System Operations / O&M

After completion of the remedial action in 1996, the site was revegetated with native species and planted long-leaf pines. Since establishment of vegetation, the site has not experienced erosion or other problems, but recent ice storms have necessitated the removal of some of the trees. Currently, the site is mowed twice a year to maintain a neat appearance along the right-of-way for NC 211.

As required in the ROD and ESD, the PRPs have been operating a pump and treat system for remediation of the surficial and Upper Black Creek Aquifers since January of 1997 and monitoring the downgradient areas since April of 1998. Figure 3 shows a conceptual flow model

of the pump and treat system. Since commencement of groundwater treatment operations, Pinnacle Consulting Group of Greenville, South Carolina has had the treatment monitoring and O&M contract for the PRPs. Initial monitoring requirements called for quarterly sampling for the first three years followed by semi-annual sampling for an additional two years. Following submission of the *Downgradient Remedy Summary Report* to the State and EPA in 2001, it was agreed by all parties that annual monitoring could be undertaken. Therefore, the most recent round of monitoring well sampling occurred in October of 2002. Monitoring well and surface water sampling locations are shown in Figures 4 and 5. Wells that are currently sampled for monitoring are as follow:

- Surficial Aquifer: MW-4S, MW-5S, MW-6S, MW-10S;
- Upper Black Creek Aquifer: MW-11D, MW-18D, MW-30D, MW-19D, MW-20D, MW-22D, MW-23D, MW-24D, MW-25D, MW-26D, MW-35D, MW-29D, MW-34D; and
- Lower Black Creek Aquifer: MW-22L, MW-25L, MW-27L, MW-37L, MW-40L, PZ-2, PZ-3, MW-28L, MW-31L, MW-38L, MW-39L, MW-32L, PZ-5, MW-36L.

Figure 6 depicts the locations of the extraction system pipelines, treatment building, and infiltration galleries.

Since initiation of operation of the pump and treat system in January 1997, there have been few problems or breakdowns of the system. In a phone conservation with Mr. Art Barnhardt of NCDENR July 30, 2003, Mr. Samuelson was informed that there are no specific records for the site delineating percent downtime versus operating time. Mr. Barnhardt also indicated that the site treatment system has operated with what he considers as "normal" maintenance issues such as the occasional replacement of an extraction pump or activated carbon barrel train. The 1992 ROD forecast an estimated annual O&M cost of $50,000 per year of operation. As currently implemented the treatment and monitoring program costs approximately $48,000 - $50,000 annually to operate. The system has treated approximately 50 million gallons of groundwater, operating at a pumping rate of 15-18 gallons per minute. The infiltration gallery contains 3 laterals; each being 175 feet long. The distribution of flow within the gallery is determined by a preset timer that activates solenoid valves at the gallery header. The timer is set to direct flow to two of the laterals at a given time. It alternates flow among the three laterals on an 8-hour cycle. As operated, each lateral will receive an average of half of the effluent from for 16 hours and no flow for the following 8 hours. The flow cycle is as follows:

First 8 hours: Flow to laterals 1 and 2;
Next 8 hours: Flow to laterals 2 and 3; and
Next 8 hours: Flow to laterals 3 and 1.

The change-out/longevity period for the carbon adsorption canisters was initially one year, but has shortened to a six month time period. It is suspected that this change is due to increasing levels of Trichloroethene (TCE) coming from up gradient of the site. No significant differences in O&M costs, as projected in the ROD and ESD, were identified. At this time, it is expected that operations will continue without modification or increased expense until remediation is complete.

Figure 3. Flow Model of the Pump and Treat System

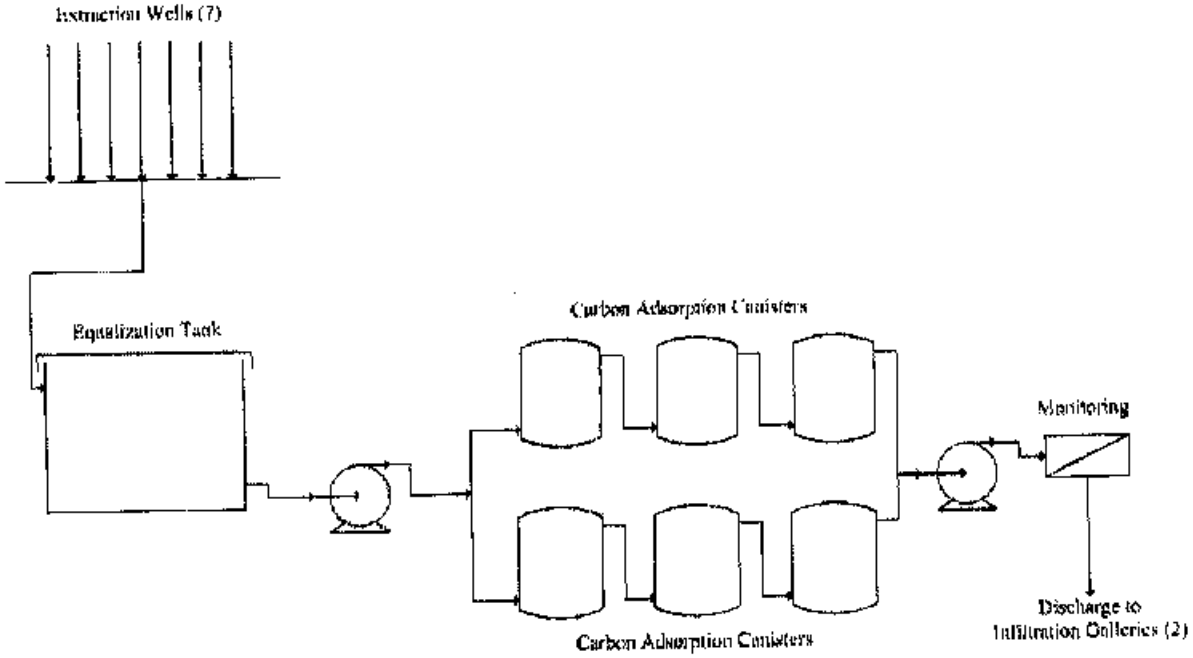


Figure 4. Monitoring Well and Sampling Locations

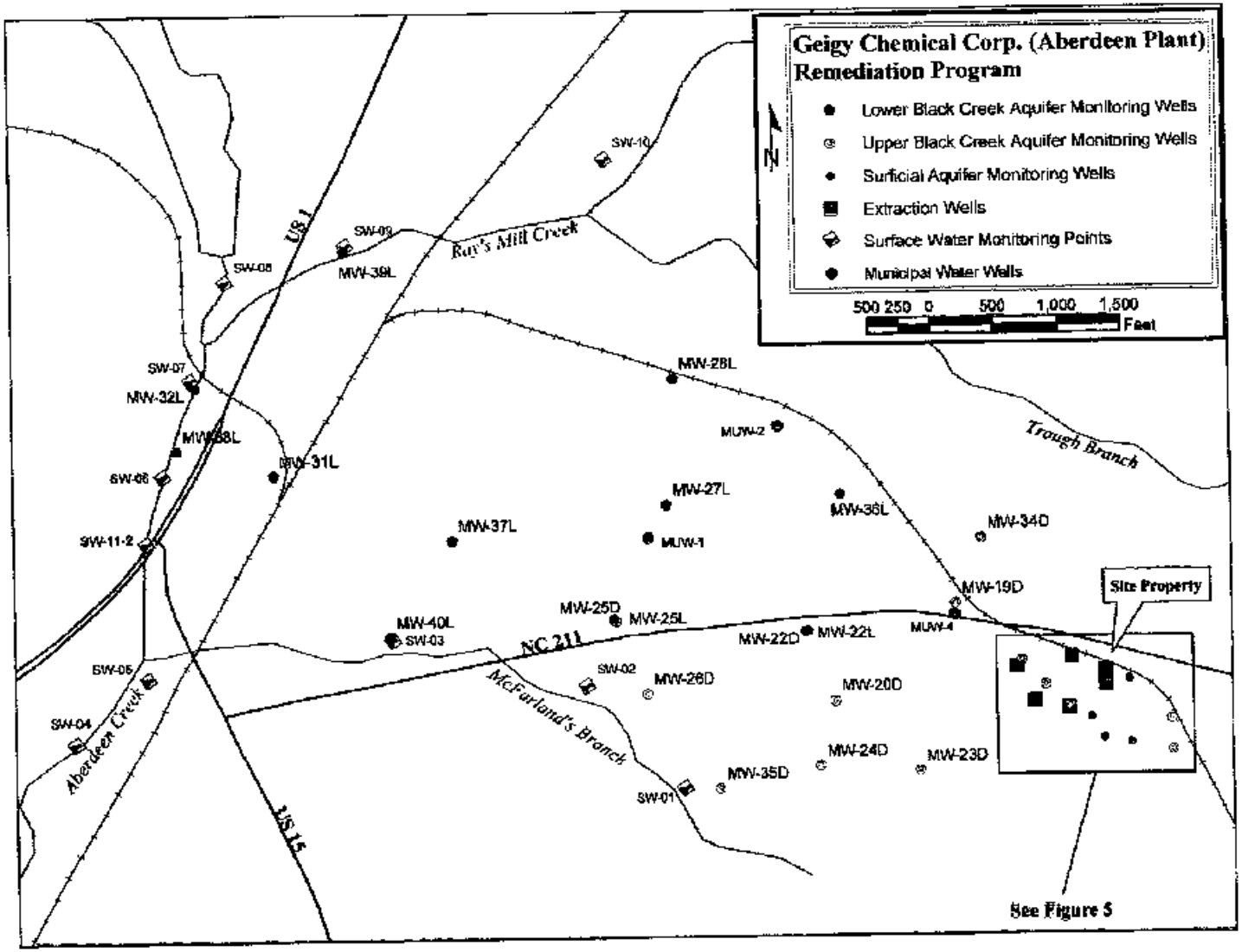


Figure 5. Site Area Monitoring and Extraction Well Locations

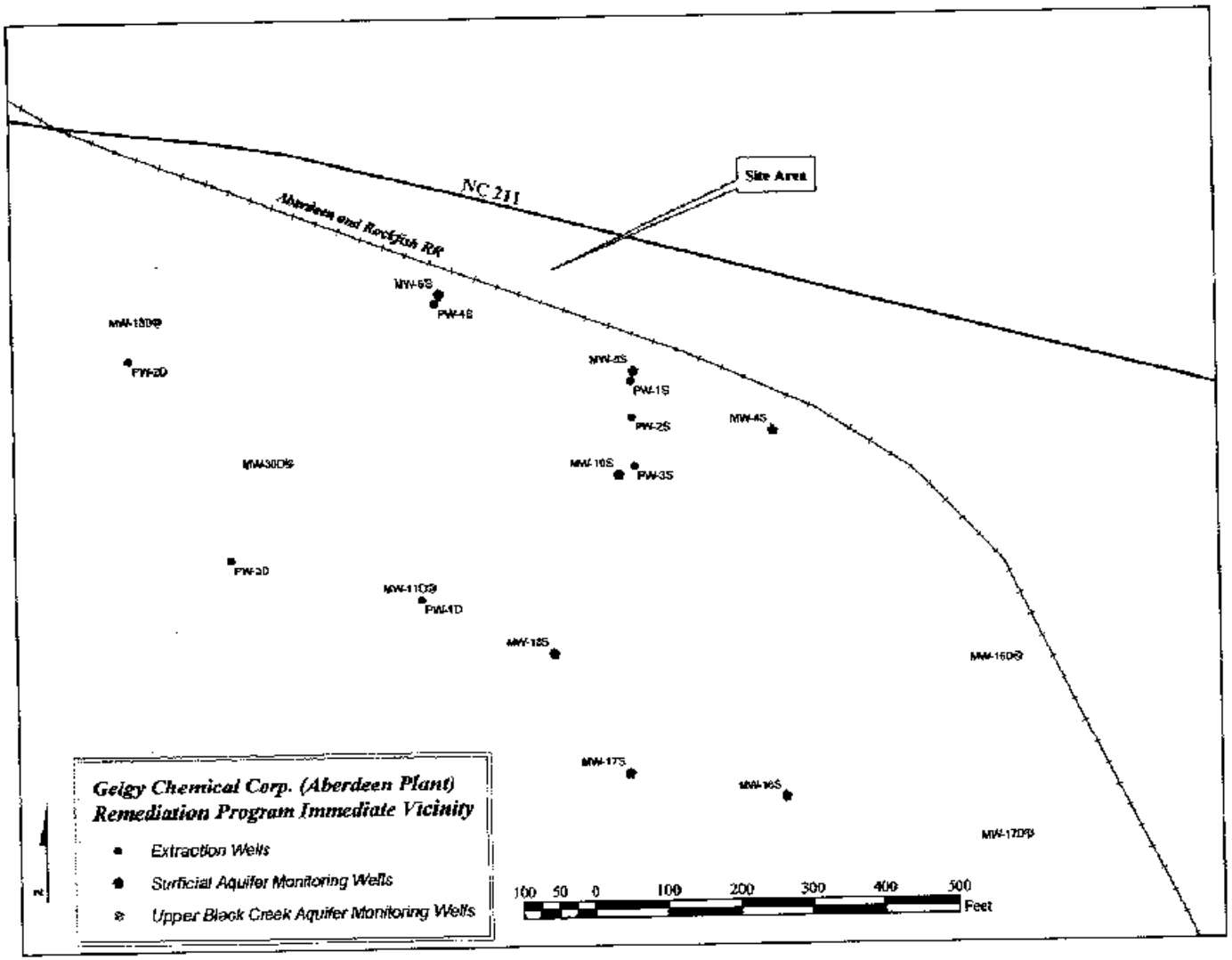
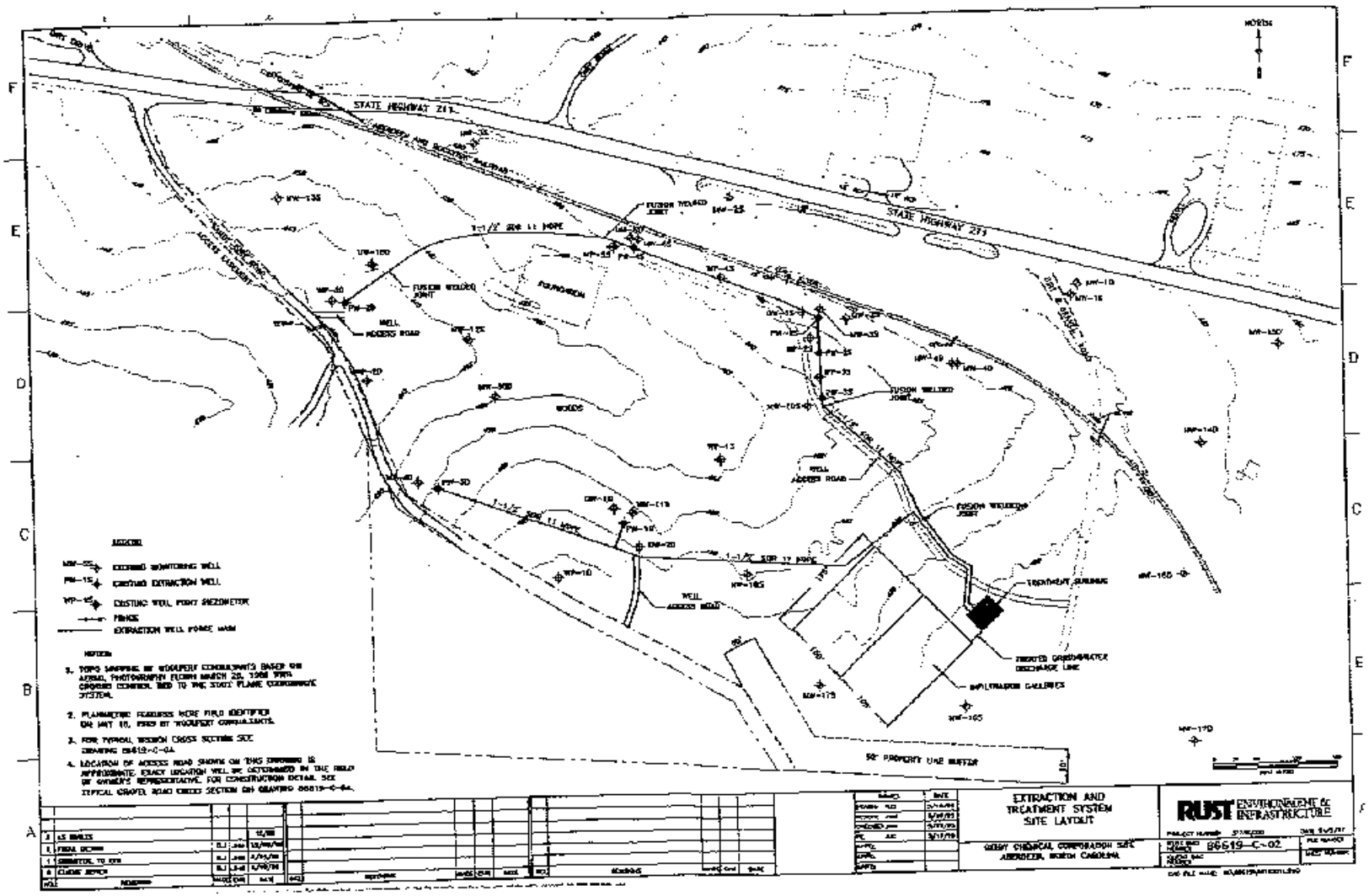


Figure 6. Extraction System and Treatment Facility Diagram



V. Progress Since the Last Five-Year Review:

Since this is the first Five-Year Review Report, no other report is available and thus no progress is reportable.

VI. FIVE-YEAR REVIEW PROCESS

The five-year review process for the Geigy Chemical Corp. (Aberdeen Plant) site included telephone discussion/interviews with the EPA Remedial Project Manager (RPM), and the lead State agency. Also included, were a visit to the Aberdeen Town Hall, the public repository for the remedial action documents, and a site visit for familiarization with the remediation activities. A list of pertinent materials from the document repository and other sources is provided in Attachment 1.

The following persons were members of the five-year review team:

- Greg Mellema, Hazardous, Toxic, and Radioactive Waste Center of Expertise (CENWO-HX-G), Omaha, NE, for QA of document preparation.
- Phil Payonk, Wilmington District, Environmental Resources Section (CESAW-TS-PE).
- Stacy Samuelson, CESAW-TS-PE.

VII. FIVE-YEAR REVIEW FINDINGS

A. Interviews

The following persons were interviewed regarding the activities and implementation of the remedial actions at the Geigy Site:

Mr. Jon Bornholm, Remedial Project Manager, EPA Region 4:

In several telephone conversations between Stacy Samuelson and Mr. Bornholm, several issues pertaining to the Geigy Site were identified. The concern for potential effects on the remedy due to the off-site TCE plume migration into the site area was identified. A second issue, full implementation of the Record of Decision in terms of fencing and signage at the site, was addressed as well. Additional discussion of these issues are provided in Sections IX, Issues, and X, Recommendations and Follow-up Actions.

Mr. Randy McElveen, Environmental Engineer, North Carolina Department of Environment and Natural Resources, Division of Waste Management, Superfund Federal Remediation Branch:

Stacy Samuelson, Wilmington District, made initial contact with Mr. McElveen through a telephone conversation. Mr. McElveen indicated that the State has no major issues with the site at this time. At the site visit, the issue of the off-site TCE plume was discussed in relation to the site remedy. The State has some concerns about the undefined source of that plume and its potential effects on the Geigy Site remedy.

B. Site Inspection

A site inspection of the Geigy Site was conducted on February 18, 2003. Attending the site visit were:

- Randy McElveen, Environmental Engineer, North Carolina Department of Environment and Natural Resources, Division of Waste Management, SF Federal Remediation Branch.
- Jon Bornholm, Remedial Project Manager, Environmental Protection Agency, Region 4.
- Ray Horn, Olin Corporation.
- Harold Moats, Syngenta Crop Systems.
- Michael Sheehan, Pinnacle Consulting Group.
- Ted Volskay, Pinnacle Consulting Group.
- Ray Livermore, U.S. Army Corps of Engineers, Wilmington District.
- Phil Payonk, U.S. Army Corps of Engineers, Wilmington District.
- Stacy Samuelson, U.S. Army Corps of Engineers, Wilmington District.

For documentation of the site visit, photos of the treatment facility and several extraction wells were taken and are attached as Attachment 2.

The site area has not been re-developed since the source remedial action was completed in 1996. The area is currently vegetated with grasses and some long-leaf pines have been planted along the railroad right-of-way. Mr. Sheehan gave a brief historical overview of the activities and locations of facilities during the source remedial action and provided a tour of the pump-and-treat facility.

C. ARAR Review

In performing the five-year review for compliance with applicable or relevant and appropriate requirements (ARARs), only those ARARs addressing risk posed to human health or the environment (i.e., addressing the protectiveness of the remedy) were reviewed. This is in keeping with current EPA guidance on five-year reviews.

Federal ARARs

- Federal Groundwater Classification – 55 Federal Register (FR) Part 8733.
- Safe Drinking Water Act of 1986, as amended (40 USC §§ 300) – 40 CFR Part 141.
- Solid Waste Disposal Act (40 USC § 6901 – 6987) – 40 CFR Part 261.
- EPA Regulations on Sole-Source Aquifers – 40 CFR 149.

State ARARs

- Identification and Listing of Hazardous Waste – 15A NCAC 13A.0006.
- North Carolina Drinking Water Act – General Statutes, Chapter 130A, Article 10.

- North Carolina Water Quality Standards – 15A NCAC 2B.
- North Carolina Groundwater Quality Standards – 15A NCAC 2L.0100, 2L.0200, 2L.0300.

The site appears to be in compliance with the ARARs identified in the ROD. There were no changes in the reviewed statutes and standards that would require changes in the remedy or management of the site.

D. Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics

No changes in the site conditions that affect exposure pathways were identified as part of the five-year review. There are no current or known changes planned in the land use and it is likely to remain rural residential immediately adjacent to the site. No new contaminants, sources, or routes of exposure were identified as part of this five-year review. There is no indication that hydrologic/hydrogeologic conditions are not adequately characterized. The rate of decrease of contaminant levels in groundwater is consistent with expectations, and the groundwater plume appears to be contained. This finding is supported by groundwater flow model simulations that were conducted by Olin Corporation and Syngenta Crop Protection to evaluate the site groundwater extraction system with respect to pesticide capture during the summer of 2003. Findings of the simulations were reported to EPA by letter report dated September 15, 2003 by the Pinnacle Consulting Group. Data from the Preliminary Design Report (Rust E&I, 1995) along with data from the monitoring program implemented in 1997 was analyzed for the simulations. Due to groundwater level and recharge rate fluctuations, three model iterations were run. The model runs were for minimum, average, and maximum extraction rates. Figures 5, 8 and 11 of the letter report show the predicted capture zone areas for the Upper Black Creek aquifer extraction wells (Attachment 3). The contaminants of concern in both groundwater and soils were reviewed in the EPA's Integrated Risk Information System (IRIS) for changes in toxicity. Review of the IRIS database revealed that toxicity and other factors for contaminants of concern have not changed with the exception of the soil contaminant chlordane. For that compound, the cancer slope factor decreased, and the reference dose increased. However, since the soil cleanup was based on cancer risk, this would have resulted in a slightly higher calculated soil cleanup value, and does not call into question the protectiveness of the remedy.

E. Data Review

Based on issues identified during document review, interviews and site inspection, the principal data reviewed were related to groundwater contaminant levels of the site and downgradient area. The main resource for review of data was the Downgradient Groundwater Remedial Action Work Plan, Geigy Chemical Corporation Site, Aberdeen, North Carolina (RAWP) (November 1997) and groundwater monitoring data provided by Pinnacle Consulting Group (October 2001).

Soil Data

Soil contamination data have not been collected since the completion of the Remedial Action. Performance Standards for soils were met or exceeded as a result of the remedial action and the results of final soil testing were reported in the Final Remedial Report For Soils (1997).

Groundwater Data

Groundwater sampling data was reviewed for sampling events occurring from May 1998 to the present. Wells were sampled quarterly for three years and then semi-annually for the last two years. Samples were analyzed for organochlorine pesticides. Starting in 2003, with coordination with the EPA and State, monitoring will be conducted annually. Over the monitoring period, some wells have been abandoned or added and several, notably MW-11D, MW-18D and MW-30D, were unable to be sampled due to drought conditions in the third quarter of 1998. Table 5 presents the detected values for BHC isomers in the surficial aquifer for wells in the current monitoring program. Graphical representation of the data for each well is presented in Attachment 4. Well MW-4S is probably not affected by the surficial aquifer extraction wells, but the other surficial monitoring wells are close enough to extraction wells to be influenced by them. The effect of the extraction wells influence on the surficial monitoring well results is not known. Of the compounds on the TCL, the BHC isomers were the most consistently detected over the sampling period. Most detected values exceed the site performance standards (Tables 3 and 4).

Table 5. Surficial BHC Isomer Concentrations in Groundwater Monitoring Wells 1990 - 2002

	Sample Date	alpha-BHC	beta-BHC	delta-BHC	gamma-BHC (Lindane)
MW-4S	11/16/1990	1	3	6	0.5
MW-4S	12/8/1993	0.28	2.1	4.7	0.066
MW-4S	12/3/1996	ND(1.25)	15	10	ND(1.25)
MW-4S	4/16/1997	ND(0.25)	8.6	7.1	ND(0.25)
MW-4S	7/14/1997	0.16	6	7.2	0.1
MW-4S	10/1/1997	0.19	6.3	6.8	ND(0.25)
MW-4S	4/21/1998	ND(1.25)	16	ND(1.25)	ND(1.25)
MW-4S	10/29/1998	ND(0.275)	4.2	2.8	ND(0.275)
MW-4S	10/14/1999	ND(0.025)	0.36	0.23	ND(0.025)
MW-4S	10/13/2000	ND(0.125)	1.5	0.66	ND(0.125)
MW-4S	10/10/2001	ND(0.025)	0.013	ND(0.025)	ND(0.025)
MW-5S	11/16/1990	5	12	12	5
MW-5S	12/9/1993	1.1	17	6.3	ND(0.5)
MW-5S	12/3/1996	ND(1.25)	17	5.6	ND(1.25)
MW-5S	4/16/1997	ND(0.5)	9.5	3.1	ND(0.5)
MW-5S	7/14/1997	0.23	5	1.8	0.15
MW-5S	10/1/1997	0.16	3.9	1.3	ND(0.125)
MW-5S	4/21/1998	ND(0.25)	2.5	0.89	0.05
MW-5S	10/29/1998	0.31	8.6	2	0.25
MW-5S	10/14/1999	ND(0.125)	1.4	0.7	ND(0.125)
MW-5S	10/13/2000	0.047	3.2	1.4	ND(0.125)
MW-5S	10/10/2001	ND(0.125)	1.3	0.17	ND(0.125)
MW-6S	11/16/1990	36	12	29	30
MW-6S	12/9/1993	7.1	9.6	9.2	6
MW-6S	12/3/1996	2.1	5.8	2.5	1.5
MW-6S	4/16/1997	2.3	6.6	1.6	1.3
MW-6S	7/14/1997	1.1	4.1	0.81	0.77
MW-6S	10/1/1997	1.3	3.8	1	0.83
MW-6S	4/21/1998	2.9	6.6	6	2.4
MW-6S	10/29/1998	1.8	7.1	4.6	1.1
MW-6S	10/14/1999	3.9	6.9	18	2
MW-6S	10/13/2000	ND(0.025)	ND(0.025)	ND(0.025)	ND(0.025)
MW-6S	10/11/2001	3.5	10	15	0.91
MW-10S	7/10/1991	2	25	2	0.8
MW-10S	12/9/1993	ND(0.5)	14	0.79	ND(0.5)
MW-10S	12/3/1996	0.026	0.58	0.045	0.07
MW-10S	4/16/1997	ND(0.25)	5.2	ND(0.25)	0.88
MW-10S	7/15/1997	0.11	1.7	0.12	0.35
MW-10S	10/1/1997	0.59	4.4	0.47	1
MW-10S	4/21/1998	0.39	7	1.6	0.34
MW-10S	10/29/1998	0.085	4.5	0.41	0.11
MW-10S	10/14/1999	0.045	2.3	0.21	0.064
MW-10S	10/13/2000	ND(0.125)	1.8	0.077	ND(0.125)
MW-10S	10/23/2002	0.01	0.56	0.027	0.014

Note: Non-Detect values represent one-half of the detection limit.

Values in bold denote detections exceeding performance standards (Table 3).

Tables 6 and 7 depict the concentration levels for the same compounds in the Upper Black Creek and Lower Black Creek aquifers. Graphical representation of the data for the Upper Black Creek Aquifer is found in Attachment 5 and the Lower Black Creek Aquifer in Attachment 6.

Table 6. Upper Black Creek Aquifer Sampling Results 1998 to 2002
Exceedences of Performance Standards for BHC Isomers

Well	2Q98	3Q98	4Q98	1Q99	2Q99	3Q99	4Q99	1Q00	2Q00	3Q00	4Q00	1Q01	4Q01	2Q02	4Q02
Wells within the extraction and treatment capture zone															
MW-11D	↑	NS	↑	NS	↑	↑	↑	↑	↑	↑	↑	↑	NS	NS	NS
MW-18D	↑	NS	↑	NS	↑	↑	↑	↑	↑	↑	↑	↑	↑	NS	NS
MW-30D	↑	↑	↑	NS	↑	↑	↑	↑	↑	↑	↑	↑	↑	NS	↑
Monitoring wells for area under remedy implementation															
MW-19D	A*	A,B,G	↑	↑	↑	↑	↑	↑	↑	A,G	↑	A,D,G	NS	NS	NS
MW-20D	A*	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
MW-22D	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
MW-23D	↑	↑	A,B,D	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
MW-24D	↑	B,G	A,B,G	↑	↑	↑	↑	A,B,G	A,B,G	↑	A,B,G	↑	NS	NS	NS
MW-25D	ND	ND	ND	↑	↑	B,D,G	ND	ND	ND	ND	ND	ND	NS	NS	NS
MW-26D	↑	↑	↑	↑	↑	↑	ND	↑	↑	↑	↑	↑	↑	↑	↑
MW-35D	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Well for assessment of groundwater quality downgradient of the Surficial aquifer well MW-33S															
MW-34D	ND	ND	ND	B	B	B	B	B	B	B	B	B	NS	NS	NS

Table 7. Lower Black Creek Aquifer Sampling Results 1998 to 2002
Exceedences of Performance Standards for BHC Isomers

Well	2Q98	3Q98	4Q98	1Q99	2Q99	3Q99	4Q99	1Q00	2Q00	3Q00	4Q00	1Q01	4Q01	2Q02	4Q02
Sentinel well for Upper Black Creek / Lower Black Creek Aquifers Interface															
MW-22L	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Monitoring wells for area under remedy implementation															
MW-25L	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
MW-27L	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
MW-31L	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
MW-37L	↑	↑	A/G	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
MW-40L	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
PZ-2	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
PZ-3	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
PZ-5	ND	↑	B/G	A/B/G	A/B/G	↑	↑	A/B/G	↑	A/B/G	↑	↑	↑	↑	A/B/G
Wells to forecast trends for Ray's Mill Creek, Aberdeen Creek, and McFarland's Branch															
PZ-2	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
PZ-5	ND	↑	B/G	A/B/G	A/B/G	↑	↑	A/B/G	↑	A/B/G	↑	↑	↑	↑	A/B/G
MW-31L	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Sentinel well for northward pesticide migration and forecast of concentration trends in Ray's Mill Creek															
MW-28L	A*	A	↑	↑	↑	↑	↑	↑	A/B	↑	B/D/G	↑	↑	↑	↑
Sentinel wells for potential migration of pesticides into Ray's Mill Creek and Aberdeen Creek															
MW-32L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-38L	ND	↑	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	D	ND
MW-39L	ND	↑	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sentinel well for Town Well No. 2															
MW-36L	ND	ND	ND	ND	ND	B	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:

↑ Denotes all BHC isomers detected and exceeding performance standards.

ND Denotes non-detect for all BHC isomers.

A - alpha-BHC, B - beta-BHC, D - delta-BHC, G - gamma-BHC

* Letter only denotes that compound detected exceeding performance standard.

NS = Not Sampled.

Trends in the BHC isomer concentrations in downgradient groundwater are varied. Several wells (MW-34D, MW-36L, MW-38L, and MW-39L) indicate no trend (little change) for the 1998 – 2002 monitoring period. Monitoring well MW-35D decreased over the same monitoring period. BHC concentrations for wells MW-37D and MW-40L slightly increased. Data for the downgradient areas seem to reflect reductions in concentrations of contaminants for the remedy area monitoring wells. However, BHC isomer concentrations were consistently above performance standards. Sentinel wells for Town Well No. 2 (MW-36L) and Ray's Mill and Aberdeen Creeks (MW-32L, MW-38L, and MW-39L) have only four instances of BHC-isomer detection during the monitoring period. Wells MW-38L and MW-39L had detection of all BHC-isomers in the third quarter 1998 sampling event; well MW-36L had detection of beta-BHC in third quarter 1999; and well MW-38L had detection of delta-BHC in second quarter 2002.

Due to the hydrology of the area, the Upper and Lower Black Creek aquifers discharge to the following surface creeks: Aberdeen Creek, McFarland's Branch, Ray's Mill Creek, and Trough Branch. Surface water sampling for the BHC isomers has been conducted since 1996 at most of the sampling points shown on Figure 3. Table 8 lists sampling results for BHC-isomers from the downgradient surface water monitoring stations. Graphs of the data for the surface water sampling sites are found in Attachment 7.

Table 8. BHC-isomer Sampling Results for Surface Water Monitoring 1996 - 2002

Site	Sample Date	alpha-BHC	beta-BHC	delta-BHC	gamma-BHC (Lindane)
SW-01	6/4/1996	0.025	0.025	0.025	0.025
SW-01	4/29/1998	0.025	0.025	0.025	0.025
SW-01	7/20/1998	0.025	0.025	0.025	0.025
SW-01	10/28/1998	0.026	0.005	0.026	0.026
SW-01	1/12/1999	0.025	0.0069	0.025	0.025
SW-01	4/12/1999	0.025	0.025	0.025	0.025
SW-01	8/10/1999	0.029	0.007	0.029	0.029
SW-01-re	8/10/1999	0.028	0.0055	0.028	0.028
SW-01	10/12/1999	0.025	0.025	0.025	0.025
SW-01	2/2/2000	0.025	0.025	0.025	0.025
SW-01	4/11/2000	0.025	0.0049	0.025	0.025
SW-01	7/21/2000	0.025	0.025	0.025	0.025
SW-01	10/14/2000	0.025	0.011	0.025	0.025
SW-01	1/9/2001	0.025	0.025	0.025	0.025
SW-01	10/9/2001	0.025	0.025	0.025	0.025
SW-01	4/9/2002	0.019	0.017	0.019	0.019
SW-01	10/25/2002	0.025	0.025	0.025	0.025
SW-02	6/4/1996	**0.052**	**0.085**	**0.097**	**0.059**
SW-02	4/29/1998	0.032	0.055	0.066	0.031
SW-02	7/20/1998	0.03	0.07	**0.076**	0.027
SW-02	10/28/1998	0.036	**0.073**	**0.079**	0.036
SW-02	1/12/1999	0.038	**0.064**	**0.07**	0.036
SW-02	4/12/1999	0.032	**0.067**	**0.075**	0.031
SW-02	8/10/1999	0.046	**0.12**	**0.11**	**0.055**
SW-02-re	8/10/1999	0.041	**0.096**	0.092	0.042
SW-02	10/12/1999	0.012	**0.054**	0.053	0.013
SW-02	2/2/2000	0.029	0.042	**0.051**	0.027
SW-02	4/11/2000	0.025	**0.052**	**0.053**	0.032
SW-02	7/20/2000	0.032	**0.075**	0.071	0.03
SW-02	10/11/2000	0.031	**0.068**	0.067	0.025
SW-02	1/9/2001	0.035	**0.068**	**0.072**	0.028
SW-02	10/9/2001	0.02	**0.054**	0.049	0.017
SW-02	4/9/2002	0.048	**0.11**	**0.11**	0.04
SW-02	7/17/2002	0.017	0.05	0.046	0.025
SW-02	10/25/2002	0.014	0.045	0.039	0.025

Values are in µg/L.
Values in red exceed the remediation goals for the downgradient area (Table 4).

Table 8 continued:

Site	Sample Date	alpha-BHC	beta-BHC	delta-BHC	gamma-BHC (Lindane)
SW-03	6/4/1996	0.044	**0.055**	**0.061**	0.035
SW-03	4/29/1998	0.034	0.043	0.05	0.023
SW-03	7/20/1998	0.027	**0.052**	**0.052**	0.016
SW-03	10/28/1998	0.029	0.048	0.049	0.017
SW-03	1/12/1999	0.034	0.045	0.048	0.024
SW-03	4/12/1999	0.032	0.05	**0.051**	0.021
SW-03	8/10/1999	0.034	**0.077**	**0.068**	0.036
SW-03-re	8/10/1999	0.029	**0.062**	**0.058**	0.024
SW-03	10/12/1999	0.014	0.022	0.0215	0.0085
SW-03	2/2/2000	0.028	0.033	0.035	0.019
SW-03	4/11/2000	0.029	0.044	0.045	0.02
SW-03	7/20/2000	0.03	**0.063**	**0.054**	0.021
SW-03	10/11/2000	0.027	0.046	0.043	0.015
SW-03	1/9/2001	0.033	**0.053**	**0.056**	0.019
SW-03	10/9/2001	0.02	0.044	0.041	0.011
SW-03	4/9/2002	0.048	0.087	0.088	0.031
SW-03	7/17/2002	0.015	0.042	0.036	0.025
SW-03	10/25/2002	0.014	0.037	0.029	0.025
SW-04	6/4/1996	0.025	0.025	0.025	0.025
SW-04	4/29/1998	0.011	0.019	0.022	0.025
SW-04	7/20/1998	0.013	0.028	0.027	0.025
SW-04	10/28/1998	0.0255	0.0255	0.014	0.0255
SW-04	1/12/1999	0.0089	0.016	0.018	0.025
SW-04	4/12/1999	0.025	0.021	0.019	0.025
SW-04	8/10/1999	0.018	0.048	0.042	0.025
SW-04-re	8/10/1999	0.014	0.033	0.03	0.025
SW-04	10/12/1999	0.005	0.0085	0.008	0.025
SW-04	2/2/2000	0.0087	0.014	0.014	0.025
SW-04	4/11/2000	0.017	0.032	0.031	0.025
SW-04	7/20/2000	0.015	0.037	0.024	0.025
SW-04	10/11/2000	0.025	0.036	0.033	0.025
SW-04	1/9/2001	0.01	0.022	0.016	0.025
SW-04	10/9/2001	0.017	0.016	0.018	0.025
SW-04	4/9/2002	0.028	0.038	0.036	0.019
SW-04	10/25/2002	0.01	0.019	0.015	0.025

Values are in µg/L.
Values in red exceed the remediation goals for the downgradient area (Table 4).

Table 8 continued:

Site	Sample Date	alpha-BHC	beta-BHC	delta-BHC	gamma-BHC (Lindane)
SW-05	6/4/1996	0.025	0.025	0.025	0.025
SW-05	7/20/1998	0.012	0.028	0.025	0.025
SW-05	10/28/1998	0.0255	0.015	0.014	0.0255
SW-05	1/12/1999	0.009	0.015	0.016	0.025
SW-05	4/12/1999	0.025	0.02	0.02	0.025
SW-05	8/10/1999	0.018	0.043	0.039	0.025
SW-05-re	8/10/1999	0.014	0.033	0.028	0.025
SW-05	10/12/1999	0.005	0.009	0.008	0.025
SW-05	2/2/2000	0.0097	0.014	0.013	0.025
SW-05	4/11/2000	0.018	0.032	0.033	0.025
SW-05	7/20/2000	0.015	0.035	0.024	0.025
SW-05	10/11/2000	0.027	0.039	0.037	0.025
SW-05	1/9/2001	0.011	0.025	0.017	0.025
SW-05	10/9/2001	0.017	0.016	0.02	0.025
SW-05	4/9/2002	0.027	0.033	0.034	0.018
SW-05	10/25/2002	0.011	0.018	0.014	0.025
SW-06	6/4/1996	0.025	0.025	0.025	0.025
SW-06	4/29/1998	0.012	0.022	0.023	0.025
SW-06	7/20/1998	0.013	0.029	0.029	0.025
SW-06	10/28/1998	0.0082	0.014	0.011	0.027
SW-06	1/12/1999	0.0082	0.016	0.016	0.025
SW-06	4/12/1999	0.025	0.025	0.025	0.025
SW-06	6/15/1999	0.028	0.013	0.012	0.028
SW-06	8/10/1999	0.016	0.048	0.039	0.025
SW-06-re	8/10/1999	0.017	0.039	0.037	0.025
SW-06	10/12/1999	0.0055	0.0085	0.008	0.025
SW-06	2/2/2000	0.0087	0.014	0.011	0.025
SW-06	4/11/2000	0.017	0.034	0.029	0.025
SW-06	7/20/2000	0.016	0.036	0.024	0.025
SW-06	10/11/2000	0.026	0.04	0.036	0.025
SW-06	1/9/2001	0.011	0.016	0.016	0.025
SW-06	10/9/2001	0.014	0.022	0.024	0.025
SW-06	4/9/2002	0.028	0.035	0.036	0.018
SW-06	10/25/2002	0.0091	0.024	0.013	0.025

Values are in µg/L.
Values in red exceed the remediation goals for the downgradient area (Table 4).

Table 8 continued:

Site	Sample Date	alpha-BHC	beta-BHC	delta-BHC	gamma-BHC (Lindane)
SW-07	6/4/1996	0.025	0.025	0.025	0.025
SW-07	4/29/1998	0.012	0.019	0.022	0.025
SW-07	7/20/1998	0.012	0.028	0.027	0.025
SW-07	10/28/1998	0.0265	0.016	0.016	0.0265
SW-07	1/12/1999	0.0084	0.016	0.018	0.025
SW-07	4/12/1999	0.025	0.019	0.02	0.025
SW-07	8/10/1999	0.018	0.057	0.041	0.025
SW-07-re	8/10/1999	0.015	0.036	0.03	0.025
SW-07	10/12/1999	0.0055	0.009	0.009	0.025
SW-07	2/2/2000	0.0084	0.0096	0.012	0.025
SW-07	4/11/2000	0.017	0.032	0.031	0.025
SW-07	7/20/2000	0.013	0.038	0.025	0.025
SW-07	10/11/2000	0.028	0.041	0.041	0.025
SW-07	1/9/2001	0.0097	0.015	0.015	0.025
SW-07	10/9/2001	0.015	0.025	0.027	0.025
SW-07	4/9/2002	0.028	0.036	0.038	0.018
SW-07	10/25/2002	0.011	0.016	0.015	0.025
SW-08	6/4/1996	0.025	0.025	0.025	0.025
SW-08	4/29/1998	0.013	0.02	0.027	0.025
SW-08	7/20/1998	0.014	0.029	0.034	0.025
SW-08	10/28/1998	0.0088	0.014	0.018	0.025
SW-08	1/12/1999	0.0097	0.019	0.019	0.025
SW-08	4/12/1999	0.025	0.021	0.021	0.025
SW-08	8/10/1999	0.018	0.042	0.05	0.025
SW-08-re	8/10/1999	0.02	0.045	0.038	0.025
SW-08	10/12/1999	0.0065	0.0105	0.009	0.025
SW-08	2/2/2000	0.01	0.015	0.014	0.025
SW-08	4/11/2000	0.022	0.039	0.04	0.025
SW-08	7/20/2000	0.018	0.037	0.029	0.025
SW-08	10/11/2000	0.035	0.048	0.047	0.025
SW-08	1/9/2001	0.011	0.019	0.019	0.025
SW-08	10/9/2001	0.021	0.039	0.041	0.025
SW-08	4/9/2002	0.031	0.043	0.042	0.018
SW-08	10/25/2002	0.014	0.024	0.019	0.025

Values are in µg/L.
Values in red exceed the remediation goals for the downgradient area (Table 4).

Table 8 continued:

Site	Sample Date	alpha-BHC	beta-BHC	delta-BHC	gamma-BHC (Lindane)
SW-09	6/5/1996	0.025	0.025	0.025	0.025
SW-09	4/29/1998	0.025	0.025	0.025	0.025
SW-09	7/20/1998	0.025	0.025	0.025	0.025
SW-09	10/28/1998	0.0255	0.0255	0.0255	0.0255
SW-09	1/12/1999	0.025	0.025	0.025	0.025
SW-09	4/12/1999	0.025	0.025	0.025	0.025
SW-09	8/10/1999	0.025	0.025	0.025	0.025
SW-09-re	8/10/1999	0.025	0.025	0.025	0.025
SW-09	10/12/1999	0.025	0.025	0.025	0.025
SW-09	2/2/2000	0.025	0.025	0.025	0.025
SW-09	4/11/2000	0.025	0.025	0.025	0.025
SW-09	7/20/2000	0.025	0.025	0.025	0.025
SW-09	10/11/2000	0.025	0.025	0.025	0.025
SW-09	1/9/2001	0.025	0.025	0.025	0.025
SW-09	10/9/2001	0.025	0.025	0.025	0.025
SW-09	4/9/2002	0.025	0.025	0.025	0.025
SW-09	10/25/2002	0.025	0.025	0.025	0.025
SW-10	4/29/1998	0.025	0.025	0.025	0.025
SW-10	7/20/1998	0.025	0.025	0.025	0.025
SW-10	10/28/1998	0.0255	0.0255	0.0255	0.0255
SW-10	1/12/1999	0.025	0.025	0.025	0.025
SW-10	4/12/1999	0.025	0.025	0.025	0.025
SW-10	8/10/1999	0.028	0.028	0.028	0.028
SW-10-re	8/10/1999	0.025	0.025	0.025	0.025
SW-10	10/12/1999	0.025	0.025	0.025	0.025
SW-10	2/2/2000	0.025	0.025	0.025	0.025
SW-10	4/11/2000	0.025	0.025	0.025	0.025
SW-10	7/20/2000	0.025	0.025	0.025	0.025
SW-10	10/11/2000	0.025	0.025	0.025	0.025
SW-10	1/9/2001	0.025	0.025	0.025	0.025
SW-11	10/12/1999	0.00495	0.0085	0.0085	0.025
SW-11	2/2/2000	0.0083	0.014	0.012	0.025
SW-11-2	2/2/2000	0.0091	0.014	0.017	0.025
SW-11-2	4/11/2000	0.016	0.031	0.029	0.025
SW-11-2	7/20/2000	0.018	0.043	0.029	0.025
SW-11-2	10/11/2000	0.027	0.04	0.037	0.025
SW-11-2	1/9/2001	0.011	0.018	0.017	0.025
SW-11-2	10/9/2001	0.014	0.026	0.029	0.025
SW-11-2	4/9/2002	0.027	0.034	0.035	0.018
SW-11-2	10/25/2002	0.01	0.016	0.012	0.025

Values are in µg/L.
Values in red exceed the remediation goals for the downgradient area (Table 4).

As a result of the downgradient investigations required by the ROD, and with the adoption of the ESD in 1998, it was determined that trichloroethene (TCE) was not a site related contaminant. As a result, monitoring and the downgradient groundwater clean-up standard for TCE was removed from the downgradient monitored natural attenuation remedy (Table 4). However, the ESD did not remove TCE from the groundwater remediation levels (performance standards) for the Geigy Site as listed in Table 3. Table 9 presents the data for monitoring wells that have been tested for TCE during the 1991 – 2002 time period. Other wells in the monitoring program for the site have not been monitored for TCE levels and are not included in Table 9.

Table 9. Trichloroethene (TCE) Concentrations in Groundwater Monitoring Wells 1991 to 2002

Trichloroethene (TCE) Concentrations in Groundwater Monitoring Wells 1991 - 2002

Surficial Aquifer		
Well	DATE	TCE Concentration (µg/L)
MW-10S	2/10/1991	ND (10)
MW-10S	12/3/1996	ND (5)
MW-10S	4/16/1997	ND (5)
MW-10S	7/15/1997	ND (5)
MW-10S	10/1/1997	ND (5)
MW-10S	4/21/1998	ND (5)
MW-10S	10/29/1998	ND (1)
MW-10S	10/14/1999	ND (1)
MW-10S	10/13/2000	ND (1)
MW-10S	10/11/2001	ND (1)
MW-10S	10/23/2002	ND (1)
MW-16S	12/3/1996	ND (5)
MW-16S	4/16/1997	ND (5)
MW-16S	7/14/1997	ND (5)
MW-16S	10/1/1997	ND (5)
MW-16S	4/21/1998	ND (5)
MW-16S	10/29/1998	ND (1)
MW-16S	10/14/1999	ND (1)
MW-16S	10/13/2000	ND (5)
MW-16S	10/11/2001	ND (1)
MW-16S	10/22/2002	ND (1)
MW-17S	12/3/1996	ND (5)
MW-17S	4/16/1997	ND (5)
MW-17S	7/14/1997	ND (5)
MW-17S	10/1/1997	[.]
MW-17S	4/21/1998	ND (5)
MW-17S	10/29/1998	ND (1)
MW-17S	10/14/1999	ND (1)
MW-17S	10/13/2000	ND (1)
MW-17S	10/11/2001	ND (1)
MW-17S	10/24/2002	ND (1)
MW-18S	12/3/1996	ND (5)
MW-18S	4/16/1997	ND (5)
MW-18S	7/15/1997	ND (5)
MW-18S	10/1/1997	0.66
MW-18S	4/21/1998	ND (5)
MW-18S	10/29/1998	ND (1)
MW-18S	10/14/1999	ND (1)
MW-18S	10/13/2000	ND (1)
MW-18S	10/11/2001	ND (1)
MW-18S	10/23/2002	ND (1)

Upper Black Creek Aquifer		
Well	DATE	TCE Concentration (µg/L)
MW-16D	2/9/1994	200
MW-16D	12/2/1996	230
MW-16D	4/16/1997	280
MW-16D	7/14/1997	250
MW-16D	10/1/1997	260
MW-16D	4/21/1998	290
MW-16D	10/29/1998	270
MW-16D	2/4/2000	290
MW-16D	10/13/2000	E (260)
MW-16D	10/10/2001	190
MW-16D	10/24/2002	160
MW-17D	2/9/1994	180
MW-17D	12/2/1996	320
MW-17D	4/16/1997	190
MW-17D	7/14/1997	370
MW-17D	10/1/1997	350
MW-17D	4/21/1998	320
MW-17D	10/29/1998	350
MW-17D	2/4/2000	330
MW-17D	10/13/2000	290
MW-17D	10/24/2002	290
MW-18D	1/26/1994	ND (3)
MW-18D	8/18/1995	ND (1)
MW-18D	12/3/1996	ND (5)
MW-18D	4/16/1997	ND (5)
MW-18D	7/14/1997	1.3
MW-18D	10/1/1997	1.6
MW-18D	4/21/1998	6.2
MW-18D	10/29/1998	4.2
MW-18D	10/14/1999	20
MW-18D	10/14/2000	29
MW-18D	10/10/2001	46
MW-18D	10/23/2002	71
MW-30D	10/14/2000	43
MW-30D	10/22/2002	66

Note: Values in µg/L, ND = Non-detect.
E = Estimated value above instrument linear calibration range. Actual detection.

TCE concentrations at wells MW-16D and MW-17D, which are at the eastern edge of the site area, are consistently two orders of magnitude (100 times) greater than the 2.8 µg/L performance standard. MW-18D, at the western edge of the area where groundwater is being extracted, consistently has TCE concentrations at one order of magnitude (10 times) the 2.8 µg/L performance standard. The trend at MW-18D is one where TCE concentrations are increasing over time. Surficial aquifer monitoring wells, MW-10S, MW-16S, MW-17S and MW-18S do not exhibit TCE concentrations above the performance standard.

VIII. ASSESSMENT

To assess the effectiveness of the remedy at the Geigy Chemical Corporation (Aberdeen Plant) Site, three basic questions are answered and discussed below:

Question A: Is the remedy functioning as intended by the decision documents?

For the Geigy Chemical Corp. (Aberdeen Plant) Site, the remedy for soil (source) contamination was completed in 1996, with the conclusion of soil and debris removal. Based on a final inspection of the site by EPA and the State of North Carolina Division of Superfund in 1998, the soil contaminant level goals established in the ROD and RD have been met and no further soil remediation is required.

The groundwater pump-and-treat system was placed on-line in January 1997 and has operated continuously since. The groundwater contamination trends attributable to the pump-and-treat remedy for the surficial and Upper Black Creek aquifers appear to be downward. The trends of contaminant concentrations in the downgradient groundwater are difficult to discern because of the low levels of contaminants present. At present, the monitoring data show that contaminant concentration levels of TCL compounds are consistently above performance level goals.

Question B: Are the assumptions used at the time of the remedy selection still valid?

The alternatives presented to address groundwater and soil contamination in the ROD, were originally evaluated using criteria set in the NCP, 40 CFR §300.430 (e)(9). The criteria are described below.

Threshold Criteria

1. Overall Protection of Human Health and the Environment addresses how an alternative as a whole will protect human health and the environment. This includes an assessment of how the public health and the environment risks are properly eliminated, reduced, or controlled through treatment, engineering controls, or controls placed on the property to restrict access and (future) development. Deed restrictions are examples of controls to restrict development.

2. Compliance with Applicable or Relevant and Appropriate Requirements (ARARs) addresses whether or not a remedy complies with all state and federal environmental and public health laws and requirements that apply or are relevant and appropriate to the conditions and cleanup options at a specific site. If an ARAR cannot be met, the analysis of the alternative must provide the grounds for invoking a statutory waiver.

Primary Balancing Criteria

3. Long-term Effectiveness and Permanence refers to the ability of an alternative to maintain reliable protection of human health and the environment over time once the cleanup goals have been met.

4. Reduction of Toxicity, Mobility, or Volume are the three principal measures of the overall performance of an alternative. The 1986 amendments to the Superfund statute emphasize that, whenever possible, EPA should select a remedy that uses a treatment process to permanently reduce the level of toxicity of contaminants at the site; the spread of contaminants away from the source of the contaminants; and the volume, or amount, or contamination at the site.

5. Short-term Effectiveness refers to the likelihood of adverse impacts on human health or the environment that may be posed during construction and implementation of an alternative until cleanup goals are achieved.

6. Implementability refers to the technical and administrative feasibility of an alternative, including the availability of materials and services needed to implement the alternative.

7. Cost includes the capital (up-front) cost of implementing an alternative, as well as the cost of operating and maintaining the alternative over the long-term, and the net present worth of both the capital and operation and maintenance costs.

Modifying Criteria

8. State Acceptance addresses whether, based on its review of the RI/FS and Proposed Plan, the State concurs with, opposes, or has no comments on the alternative EPA is proposing as the remedy for the site.

9. Community Acceptance addresses whether the public concurs with EPA's proposed plan. Community acceptance of this proposed plan will be evaluated based on comments received at the public meetings and during the public comment period.

The evaluation criteria relate to the requirements of Section 121 of CERCLA, 42 USC §9621, which determine the overall feasibility and acceptability of the remedy. Threshold criteria must be satisfied in order for a remedy to be eligible for selection. Primary balancing criteria are used to weigh major trade-offs between remedies. State and community acceptance are modifying criteria formally taken into account after public comment is received on the

proposed plan. Table 10 summarizes the alternatives evaluated and discussion of the potential remedial alternatives to address soil and groundwater follow.

Table 10. Remedial Alternative Summary

	Remedial Action	Total Present Worth Costs (1992)
Groundwater		
Alternative 1A	No Action	$140,000
Alternative 1B	Long-term Monitoring of Groundwater	$1,630,000
Alternative 2	Slurry Wall and Cap	$10,200,000
Alternative 3	Groundwater Extraction for Remediation Levels; Carbon Adsorption; Discharge to POTW	$2,210,000
Soil		
Alternative 1	No Action	$140,000
Alternative 2	Off-site Disposal Total Landfilling Total Incineration	 $600,000 $2,440,000
Alternative 3	Capping	$275,000
Alternative 4	On-Site Thermal Desorption	$700,000
Alternative 5	On-Site Incineration	$1,327,100

Ground Water Remediation

The following alternatives were subjected to detailed analysis for groundwater remediation:

Alternative 1A: No Action

Alternative 1B: Long-term Monitoring of Groundwater

Alternative 2: Slurry Wall and Cap

Alternative 3: Groundwater Recovery and Treatment to Attain Remediation Levels

Overall Protection of Human Health and the Environment

Groundwater poses no risks to human health under current conditions. Under the future use condition the no action alternative would not address pesticide levels in groundwater and therefore would not be protective of human health. Alternative 2 would attain the remediation goals by containing groundwater in the uppermost aquifer and recovering groundwater in the second uppermost aquifer. Alternative 3 would attain the remediation goals by recovering

groundwater in the uppermost and second uppermost aquifer. Therefore, Alternatives 2 and 3 would be protective of human health and the environment.

Compliance With ARARs

The no action alternative would not comply with ARARs. Alternative 2 would attain remediation levels outside of the slurry wall in the second uppermost aquifer and prevent remediation levels from being exceeded off-site in the uppermost aquifer. Alternative 3 would attain remediation levels in both aquifers. The cap in Alternative 2 would be designed to conform to RCRA performance standards. Construction of the groundwater recovery, treatment and discharge systems for Alternatives 2 and 3 would satisfy action-specific ARARs. Discharge to an on-site infiltration gallery would comply with the substantive aspects of a NC Non-Discharge Permit.

Long-term Effectiveness and Permanence

Pesticide levels would decrease permanently through recovery outside of the slurry wall for Alternative 2 and in both aquifers in Alternative 3. Construction of a slurry wall under Alternative 2 would be complicated by the depths to the uppermost aquitard (up to 70 feet). The competence of the resulting connection would be verified through hydraulic and analytical monitoring of groundwater. Carbon adsorption is considered Best Available Treatment for pesticides in groundwater. Alternative 2 would be a permanent installation that would require review and maintenance indefinitely. Alternative 3 would be discontinued once the remediation levels were achieved.

Reduction of Toxicity, Mobility, and Volume

Alternative 2 would reduce the mobility of pesticides in the uppermost aquifer through containment and reduce the volume of pesticides in the second uppermost aquifer through recovery. Alternative 3 would reduce the volume of pesticides in both aquifers through recovery and treatment and comply with the statutory preference for alternatives involving treatment.

Short-term Effectiveness

All of the alternatives can be implemented without significant risks to the community or on-site workers and without adverse environmental impacts. Construction schedules would be as follows: Alternative 1A – None; Alternative 1B – 1 month; Alternative 2 – 8 months; and Alternative 3 – 3 months. Construction of Alternative 2 could not proceed until the rail line was rerouted, a potentially significant obstacle on an institutional basis.

Implementability

Alternatives 1A, 1B, and 3 would not pose significant concerns regarding implementation. Construction of the slurry wall for Alternative 2 would approach the limits of technical feasibility due to the required depths (up to 70 feet). Design of the treatment system for Alternatives 2 and 3 could not be conducted until discharge requirements were defined.

Cost

Total present worth costs (1992) for the groundwater alternatives are presented in Table 10.

Soil Remediation

The following alternatives were developed for Site soils and were subjected to detailed analysis:

Alternative 1:	No Action
Alternative 2:	Off-Site Disposal
Alternative 3:	Capping
Alternative 4:	On-Site Thermal Desorption
Alternative 5:	On-Site Incineration

The evaluation of these alternatives is summarized below.

Overall Protection of Human Health and the Environment

Potential risks due to Site soils under current and potential future conditions (residential scenario) are within the acceptable range of risk specified by the National Contingency Plan (NCP).

Compliance with ARARs

There are no Federal or State ARARs for pesticides in soils. Alternative 2 would comply with EPA's off-site policy and applicable land disposal restrictions. Alternative 3, consolidation of site soils and capping in place would not trigger any RCRA requirements. Alternatives 4 and 5 would comply with all applicable ARARs, including LDRs.

Long-term Effectiveness and Permanence

Alternative 1 would not be effective in reducing contaminant levels. Alternatives 2 and 4 would result in a permanent reduction in site risks. Alternative 3 could be effective in the long-term through regular maintenance of the cap, but a review of remedy would be required every five years since a cap is not considered a permanent remedy. Alternatives 4 and 5 would maintain reliable protection of human health and the environment over time once the remediation levels were achieved.

Reduction of Toxicity, Mobility, and Volume

Pesticide levels would remain unchanged for Alternative 1. Alternatives 2, 4 and 5 would reduce pesticide levels significantly. Alternative 3 would not reduce the volume, but would reduce the mobility and effective toxicity of the pesticides.

Short-term Effectiveness

All of the alternatives can be implemented without significant risks to on-site workers or the community and without adverse environmental impacts.

Implementability

No implementation is needed for the no action alternative. Off-site disposal to a RCRA-approved landfill and incinerator have been conducted successfully in the past at the Geigy Site. Construction of the cap would pose no significant difficulties. Alternatives 4 and 5 are implementable, however the low volume of contaminated soils requiring remediation renders these alternatives impractical at this site.

Cost

Total present worth costs (1992) for the soil remediation alternatives are presented in Table 10.

Modifying Criteria

State and community acceptance are modifying criteria that were considered in selecting the remedial action.

State Acceptance

The State of North Carolina concurred with the selected remedy.

Community Acceptance

A proposed plan fact sheet was released to the public on March 26, 1992. The proposed plan public meeting was held on March 31, 1992. The public comment period on the proposed plan was held from March 26, 1992 to May 25, 1992. The letters, comments, and questions asked during the March 31st meeting and received during the comment period were attached to the ROD as a Responsiveness Summary.

With the completion of the *Downgradient Groundwater Remedial Action Work Plan* in October 1997, the alternative of Monitored Natural Attenuation was implemented for the downgradient portion of the plume. The determination was based on the following factors:

- There were no receptors of untreated groundwater in the downgradient area. At the time there was one private well user in the area. All other residences and businesses are connected to the city water system. The private well had been sampled and the water was contaminated with pesticides. However, the PRPs installed a carbon filter on the well, and conducted periodic monitoring to ensure proper operation and maintenance.

- The City of Aberdeen, by letter dated April 1997, informed EPA that the City would not install any municipal water supply wells in this downgradient area.

- Groundwater discharge to surface water limits the further migration of the plume. Groundwater flow directions have been identified to verify that the groundwater pesticide contamination plume is contained by the following creeks: McFarland's Branch, Aberdeen Creek, Ray's Mill Creek, and Trough Branch.

- Pesticide concentrations in surface water do not currently pose a risk to human health or wildlife. The risk assessment for McFarland's Branch was updated based on the new sampling results and indicates that the risk associated with the downgradient plume is well below EPA's acceptable risk range of 10^{-4} to 10^{-6}.

- Groundwater modeling has shown that the concentrations of pesticides in this downgradient area will decrease in a time frame comparable to a pump-and-treat system. A groundwater flow model was used to simulate the performance of six extraction wells in the downgradient plume area. The model was also used to estimate the extent and longevity of the groundwater plume under naturally-occurring conditions. The results of this modeling show that the plume would be remediated in 19 years under pump-and-treat conditions, and would be remediated in 25 years under natural conditions.

The assumptions used for the remedy selection remain valid. The selection of extraction with activated carbon adsorption as the remedy for the surficial and Upper Black Creek aquifers is still valid as there have not been any changes to the assumptions made originally. The selection of monitored natural attenuation as the remedy for the downgradient area is still valid as conditions have not fundamentally changed. Based on the review, all appropriate measures and procedures were utilized at the time of the remedial action and continue to be in effect.

Question C: Has any information come to light that could call into question the protectiveness of the remedy?

Based on validated information provided in the documentation that was reviewed, there is no information to date that significantly questions the protectiveness of the remedy. Data collected since the conclusion of the source remedial action support the selection of extraction with treatment as the preferred method for groundwater remediation in the ROD. The data are also in support of selection of monitored natural attenuation as the preferred method of groundwater remediation in the downgradient area as selected in the ESD. The trends of contaminant concentrations in groundwater are generally downward. However, detections of

target contaminants are frequently in exceedance of performance standards for the site. Remedy implementation data to date provide no validated early indication of potential remedy failure.

IX. ISSUES

There are several problems or issues that have been identified during this review. Each is further discussed in the recommendations section of this report.

1. Fencing and signage for the site as proposed in the documents of record have not been installed.

2. Modification of the site Groundwater Remediation Discharge Permit to reflect actual number of recovery wells in use.

3. Extension of off-site trichloroethene (TCE) contaminant plume into site area and potential affects on remedy as implemented. Potential increases in TCE concentrations in the remedy and downgradient areas.

X. RECOMMENDATIONS AND FOLLOW-UP ACTIONS

The recommendations and follow-up actions associated with the issues found in this review are described below and are summarized in Table 9.

Implementation of site fencing and signage as proposed in the Record of Decision should be analyzed. The proposal for fencing and signage was completed prior to remediation of the site soils. With removal of the contaminated soils, fencing the site may pose a greater public safety hazard than exists currently. It is recommended that EPA issue an ESD to eliminate the requirement for fencing and signage at the site.

The current Groundwater Remediation Permit issued to the Site by the State does not reflect the treatment system as installed. The permit lists a total of five (5) recovery wells while the actual number of recovery wells in use is seven (7). As the current permit expires June 30, 2004, it is recommended that the PRPs update the information in the permit application for renewal. Change of the permit should only be editorial in nature and should not affect the operation or implementation of the treatment system.

Extension of the off-site trichloroethene (TCE) contaminant plume into the site treatment area has been noted during ongoing monitoring of the remedy. The change-out period for activated carbon canisters has reduced from annually to semi-annually. Currently there are insufficient data to accurately predict whether the TCE plume will adversely affect the remedy as implemented or not. It is recommended that the EPA and State continue to pursue characterization of the source of the TCE and the PRPs continue their voluntary monitoring of wells in accordance with the Site Groundwater Remediation Permit.

Table 11. Recommendations and Follow-up Actions

Issue(s)	Recommendations/Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Follow-up Actions: Affects Protectiveness (Y/N)
Fencing and signage for the site as proposed in the documents of record have not been implemented.	Fencing and signage should not be required as the site soils have been remediated. EPA should issue an ESD to eliminate requirement for fencing and signage.	EPA	EPA and State	Before next five-year review as required	N
Groundwater Remediation Permit does not cover all installed recovery wells.	Update permit to reflect actual number of recovery wells when renewed.	PRPs	State	Upon renewal of current permit – June 30, 2004	N
Off-site trichloroethene contaminant plume.	Continued monitoring of affect(s) on the site remedy.	PRPs, EPA and State	EPA and State	Before next five-year review or as required	N

XI. PROTECTIVENESS STATEMENTS

The remedy at the Geigy Chemical Corp. (Aberdeen Plant) Site is expected to be or is protective of human health and the environment, and in the interim, exposure pathways that could result in unacceptable risks are being controlled.

XII. NEXT REVIEW

This is a site that requires five-year statutory reviews. EPA will conduct the next review within five years of the completion of this first five-year review report. The completion of this review as shown on the signature cover to this report is the trigger for the next five-year review.

ATTACHMENT 1
List of Documents Reviewed

List of Documents Reviewed
Geigy Chemical Corp. (Aberdeen Plant) Five-Year Review

Rust Environment & Infrastructure. November 1993. Remedial Design Work Plan, Geigy Corporation Site, Aberdeen, North Carolina. Project No. 86619.200.

Rust Environment & Infrastructure. November 1993. Sampling And Analysis Plan, Geigy Chemical Corporation Site, Aberdeen, North Carolina. Project No. 86619.210.

Rust Environment & Infrastructure. February 1995. Downgradient Groundwater Investigation Work Plan, Geigy Chemical Corporation Site, Aberdeen, North Carolina.

Rust Environment & Infrastructure. March 1996. Downgradient Investigation Data Summary Report, Geigy Chemical Corporation Site, Aberdeen, North Carolina. Volume 1 and 2. Project No. 33288.610.

Rust Environment & Infrastructure. March 1996. Final Design Report, Geigy Chemical Corporation Site, Aberdeen, North Carolina. Project No. 86619.600.

Rust Environment & Infrastructure. November 1997. Final Downgradient Groundwater Remedial Action Work Plan, Geigy Chemical Corporation Site, Aberdeen, North Carolina. Project No. 201165.10300.

Sirrene Environmental Consultants. March 16, 1992. Feasibility Study Report, Geigy Chemical Corporation Site, Aberdeen, North Carolina. Sirrine Project No. G-1024.20.

The Pinnacle Consulting Group. October 2001. Downgradient Remedy Summary Report, Geigy Chemical Corporation Site, Aberdeen, North Carolina. Project No. MAS0006I.

The Potentially Responsible Parties (PRPs) for the Geigy Chemical Corporation Site. November, 1989. Remedial Investigation/Feasibility Study Work Plan, Geigy Chemical Corporation Site, Aberdeen, North Carolina. Prepared by ERM – Southeast, Inc.

The Potentially Responsible Parties (PRPs) for the Geigy Chemical Corporation Site. March 1992. Final Report – Remedial Investigation Study, Geigy Chemical Corporation Site, Aberdeen, North Carolina. Prepared by ERM – Southeast, Inc.

U.S. Environmental Protection Agency, Waste Management Division. May 1, 1989. Initial Soil Removal Report Task 10 – RI/FS, Geigy Chemical Corp. Site, Aberdeen, North Carolina. Prepared by the Potentially Responsible Parties (PRPs) for the Geigy Chemical Corp. Site.

U.S. Environmental Protection Agency, Region IV. March 24, 1992. Geigy Chemical Corp. Site NPL Site Administrative Record, Index and Volume 1 through 7.

U.S. Environmental Protection Agency, Region IV. August 27, 1992. Record of Decision; Summary of Remedial Alternative Selection; Geigy Chemical Corporation Site, Aberdeen, Moore County, North Carolina.

U.S. Environmental Protection Agency, Region IV. January 23, 1998. Explanation of Significant Differences to the Remedial Action, Geigy Chemical Corporation Site, Aberdeen, Moore County, North Carolina.

U.S. Environmental Protection Agency, Region IV. February 6, 1998. Geigy Chemical Corp. (Aberdeen Plant) Site (Explanation of Significant Differences) NPL Site Administrative Record, Index and Volume 1 through 3.

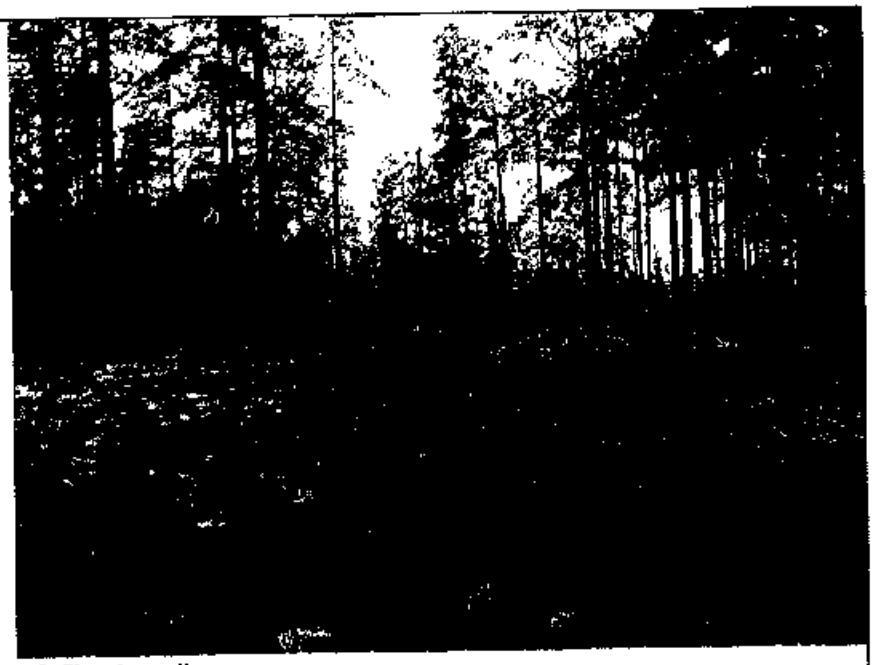
U.S. Environmental Protection Agency, Region IV. July 21, 1998. Superfund Preliminary Close-Out Report, Geigy Chemical Corporation NPL Site, Aberdeen, North Carolina.

ATTACHMENT 2
Photos of Extraction System Installations
All photos taken by Stacy Samuelson
during Site visit February 18, 2003

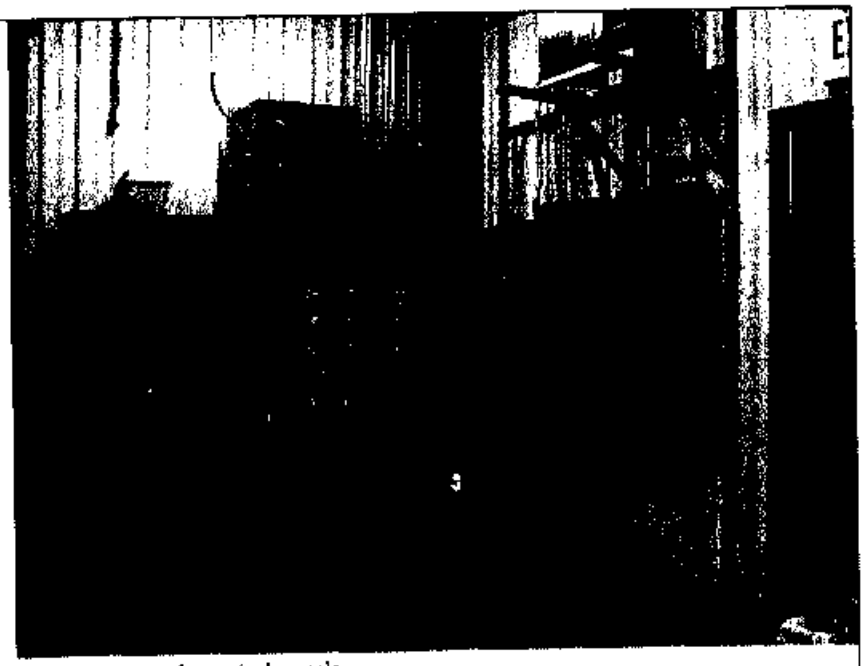
Equalization Tank

Equalization tank and transfer pump

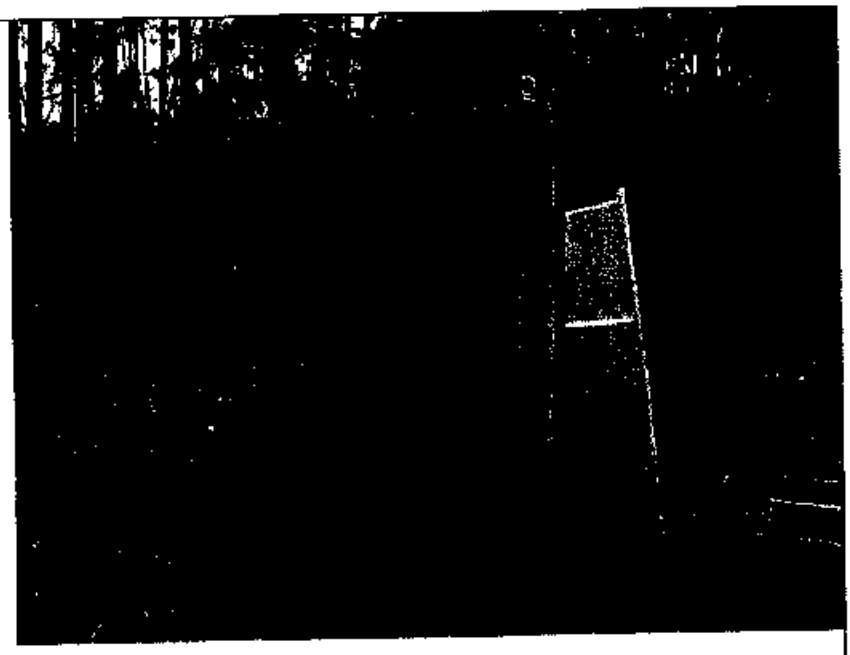
Extraction well PW-3S



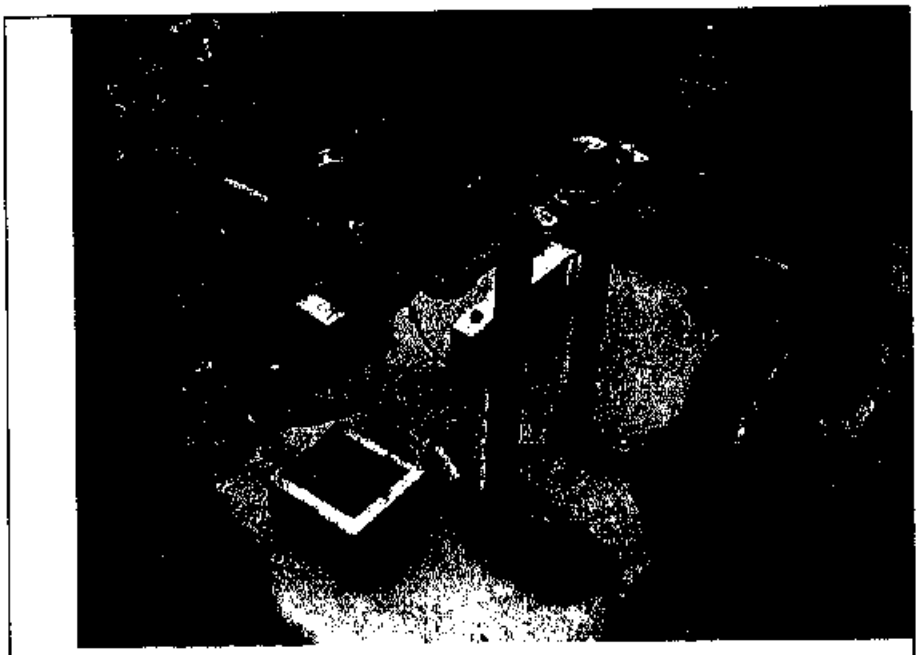
Infiltration gallery area



Treatment system main control panels

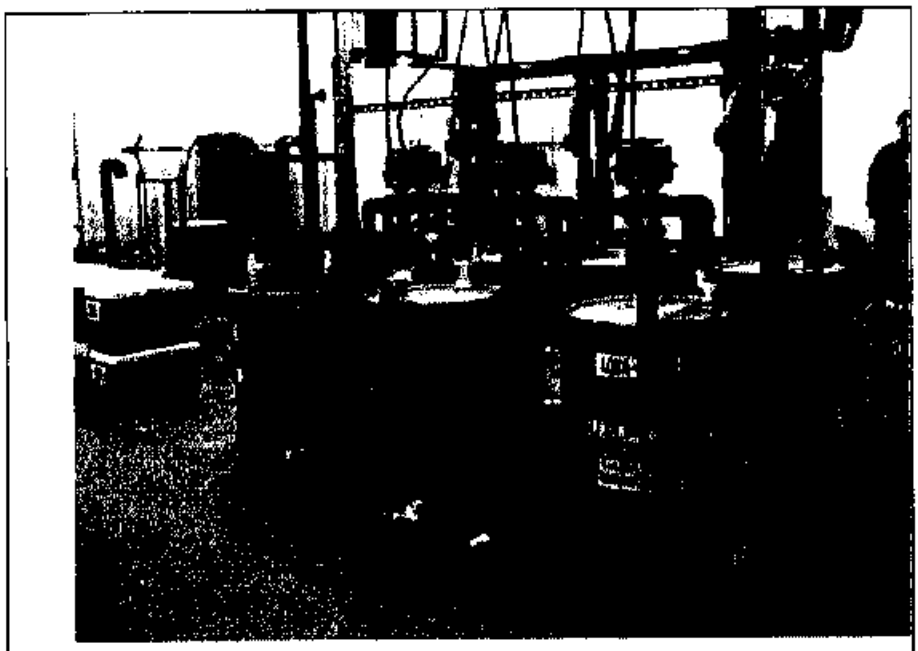


Controller box/panel for extraction well



Detail of extraction well PW-3S

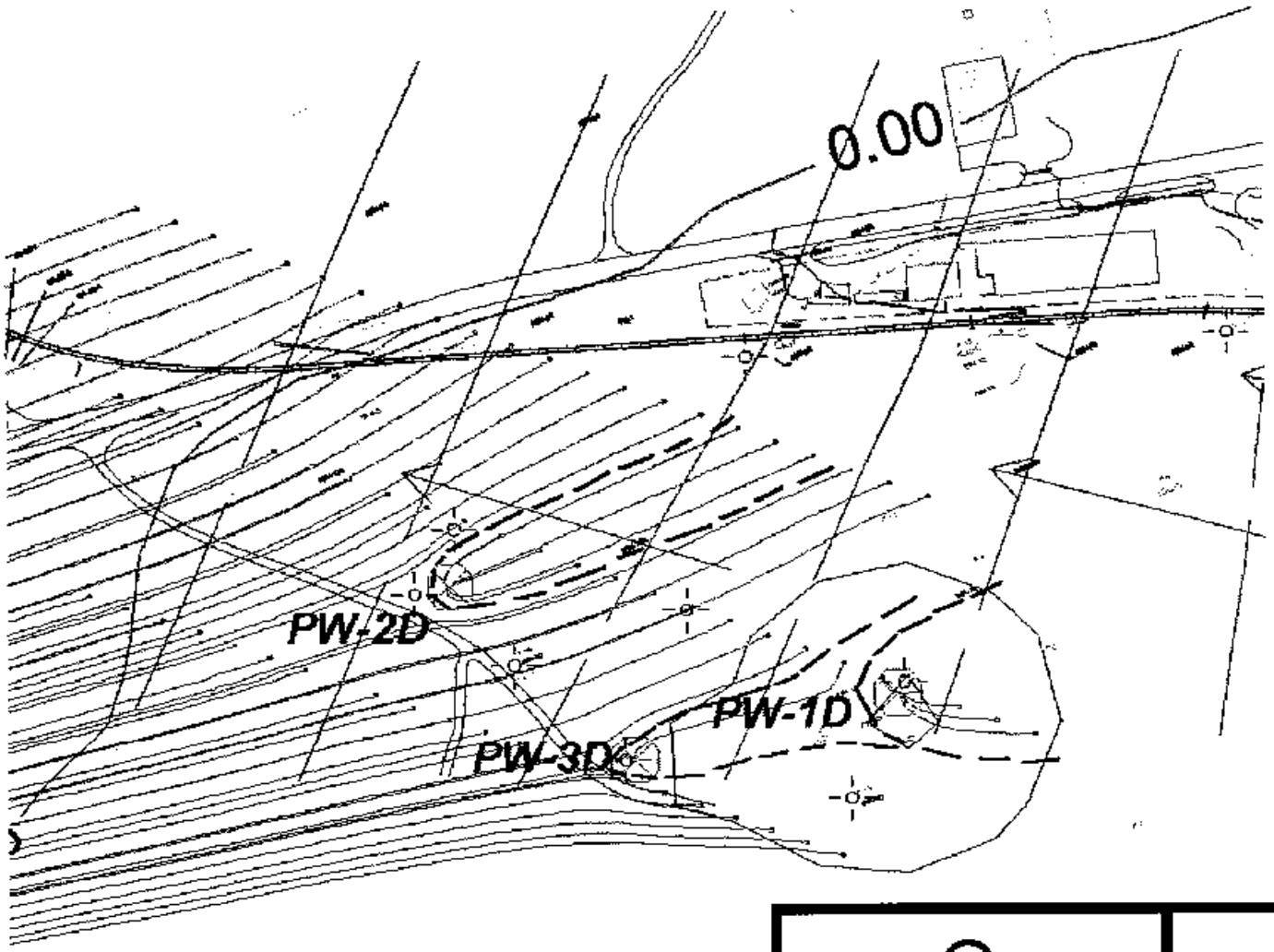
View of extraction wells PW-2S and PW-1S from well PW-3S



View of carbon adsorption canister banks

Attachment 3
Upper Black Creek Aquifer
Extraction Well Capture Zones

Close-Up: Min Q and Drawdown Contours

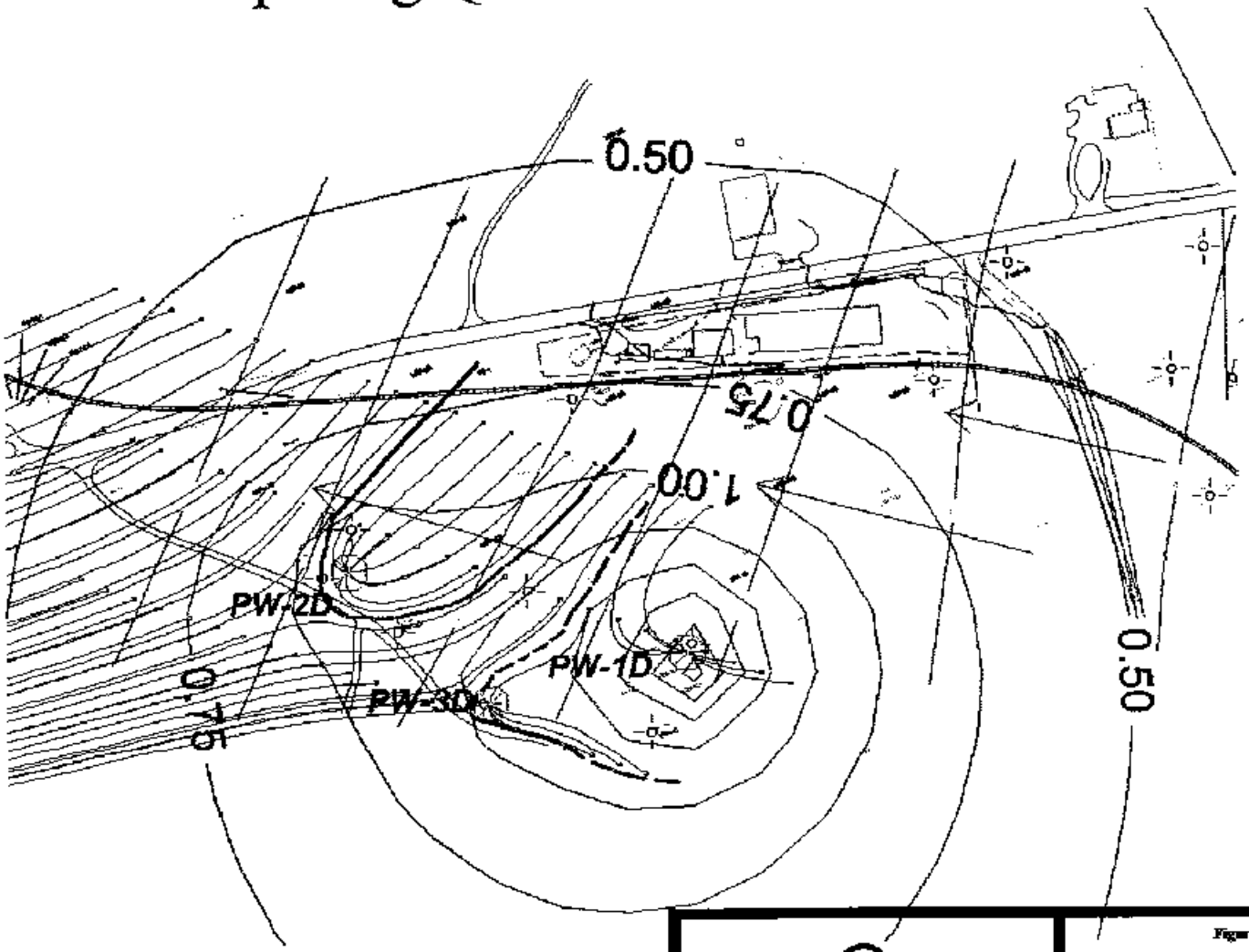


EARTH TECH
A DAMES INTERNATIONAL LTD. COMPANY

Figure 5

Gelgy Site, North Carolina September 2005

Close-Up: Avg Q and Drawdown Contours

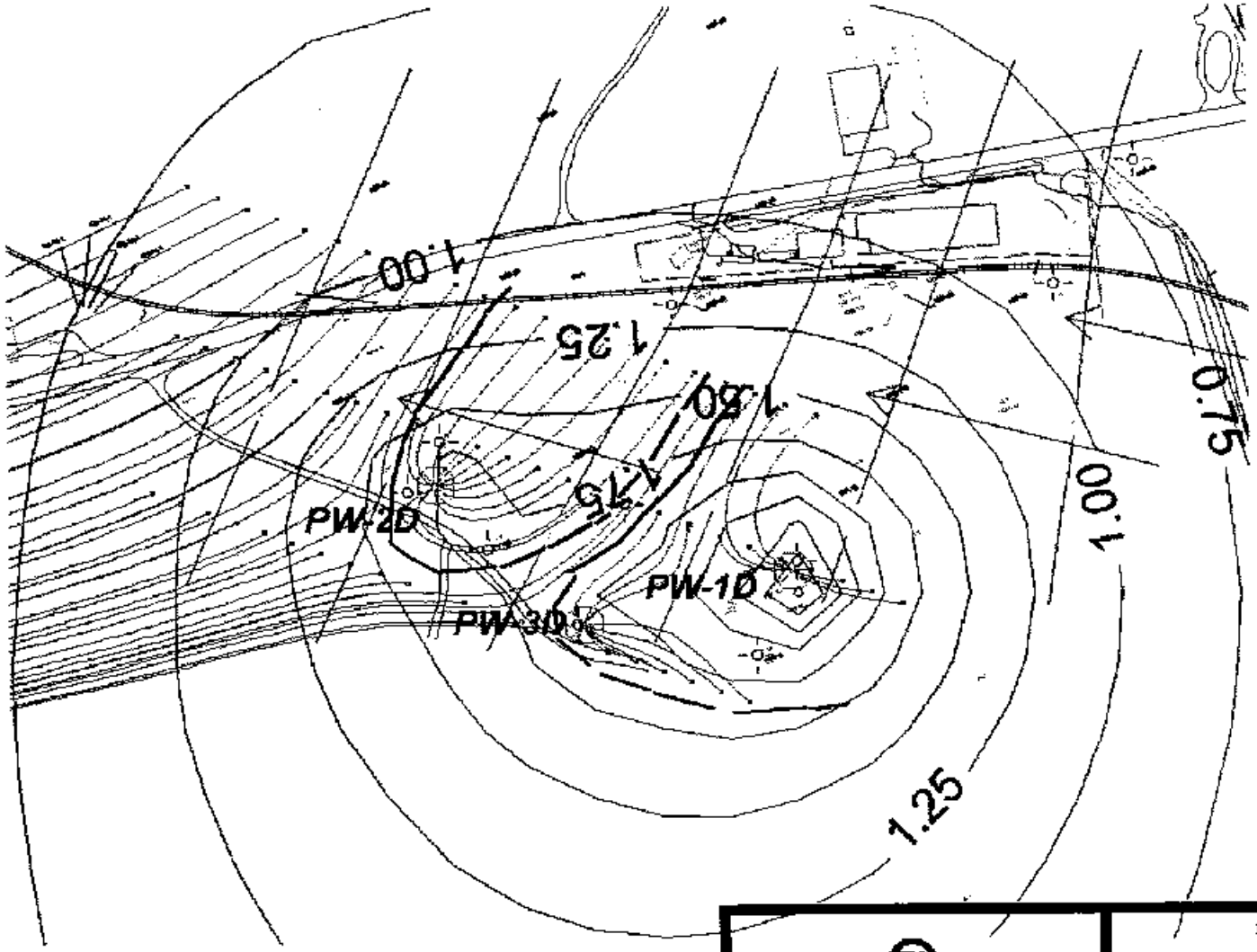


EARTH TECH
A TETRA TECH INTERNATIONAL LTD. COMPANY

Figure 8

Geigy Site, North Carolina September 2003

Close-Up: Max Q and Drawdown Contours



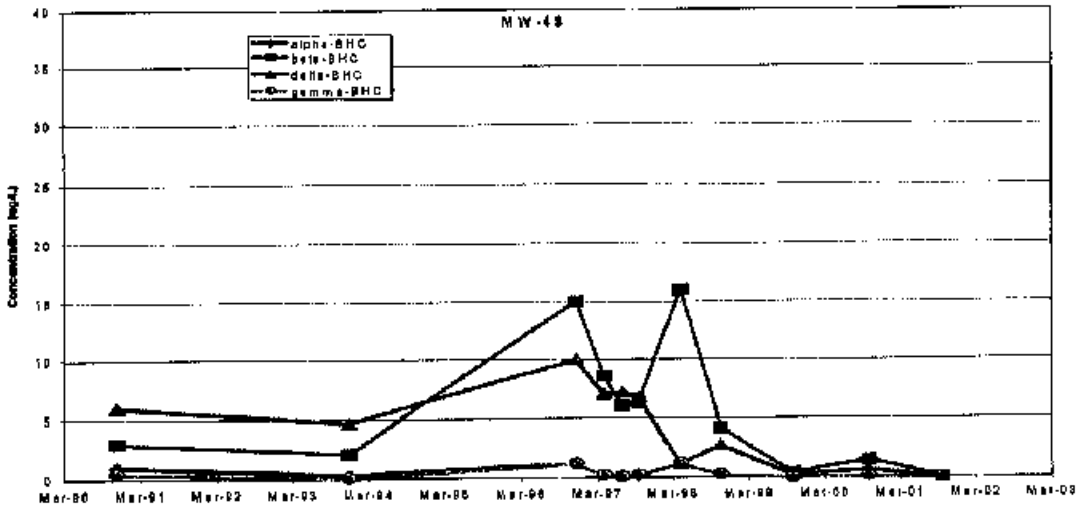
EARTH TECH
A TETRA TECH INTERNATIONAL LTD. COMPANY

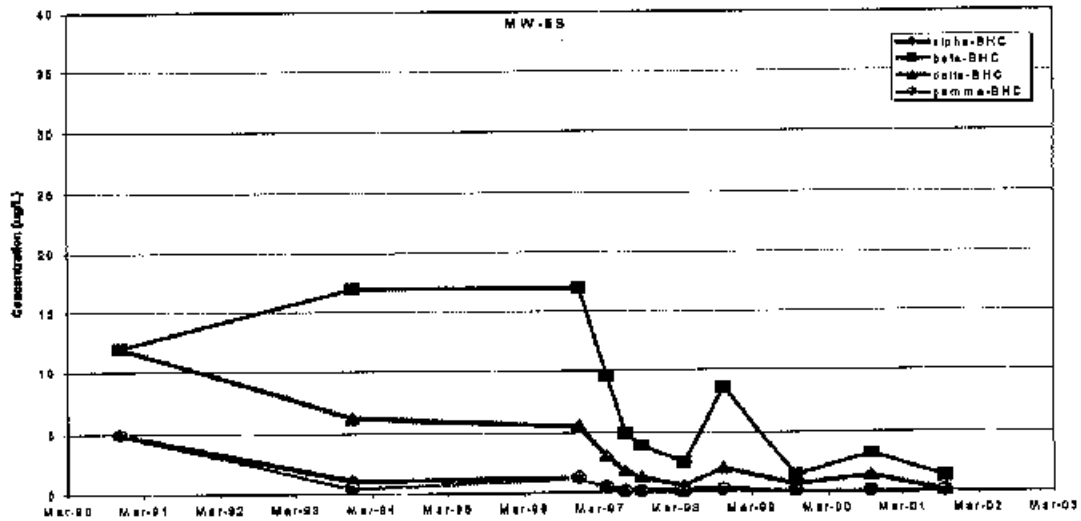
Figure 11

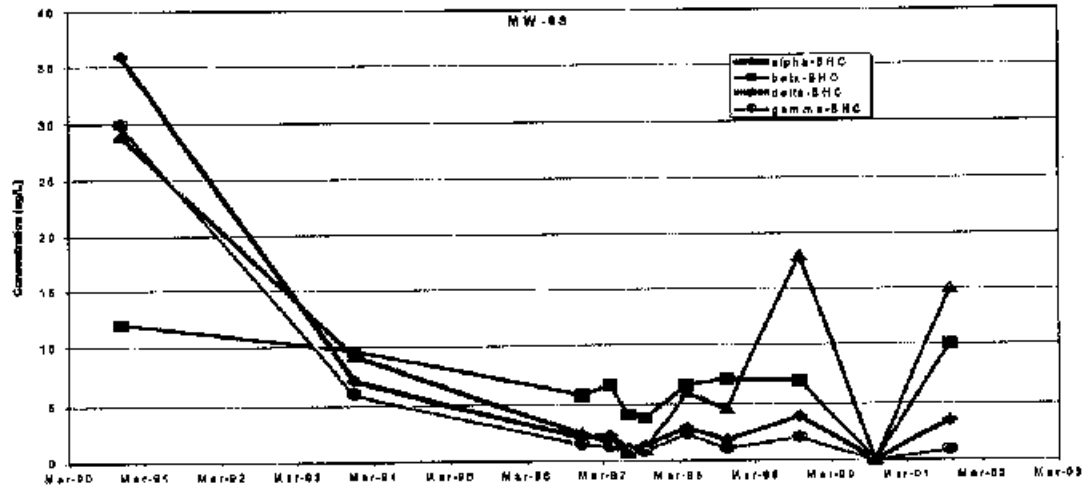
Geigy Site, North Carolina September 2003

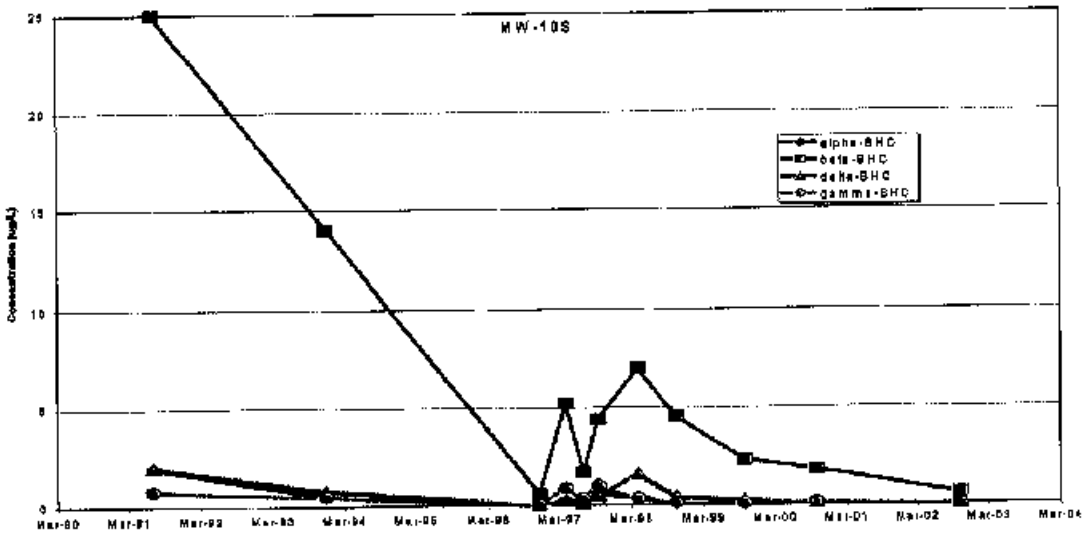
Attachment 4

Surficial Aquifer Graphs


MW-4S
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (ug/L)
0
5
10
15
20
25
30
35
40
Mar-90
Mar-91
Mar-92
Mar-93
Mar-94
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02
Mar-03

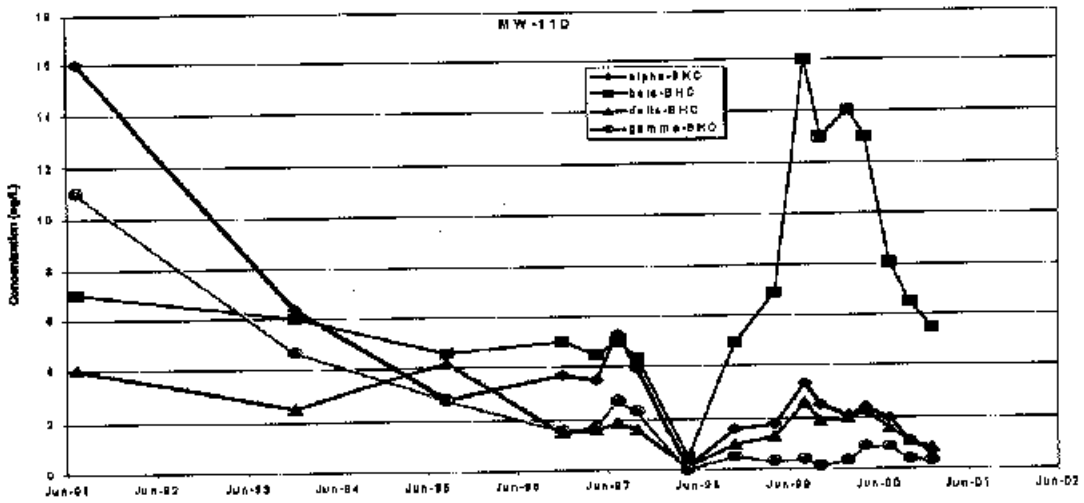

MW-5S
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (ug/L)
0
5
10
15
20
25
30
35
40
Mar-90
Mar-91
Mar-92
Mar-93
Mar-94
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02
Mar-03

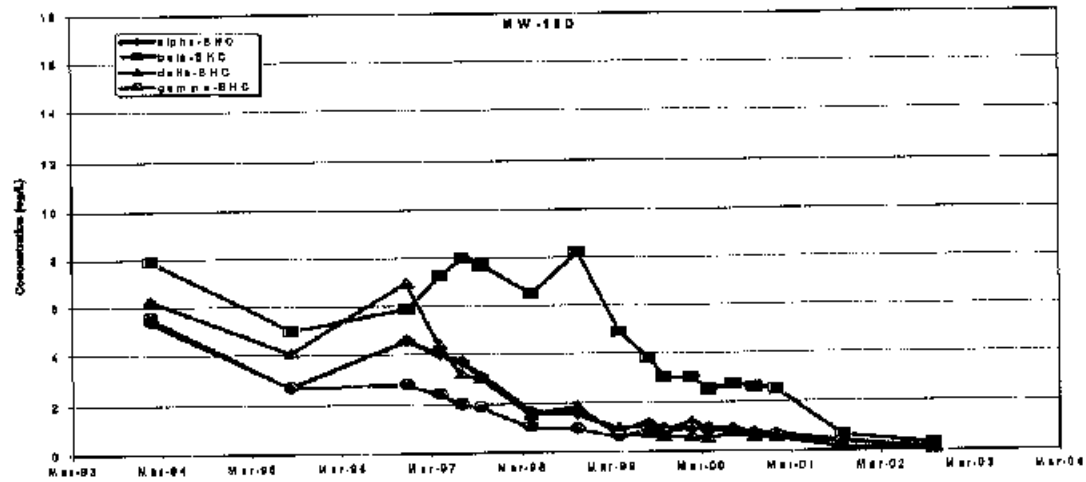

MW-6S
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (ug/L)
0
5
10
15
20
25
30
35
40
Mar-90
Mar-91
Mar-92
Mar-93
Mar-94
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02
Mar-03

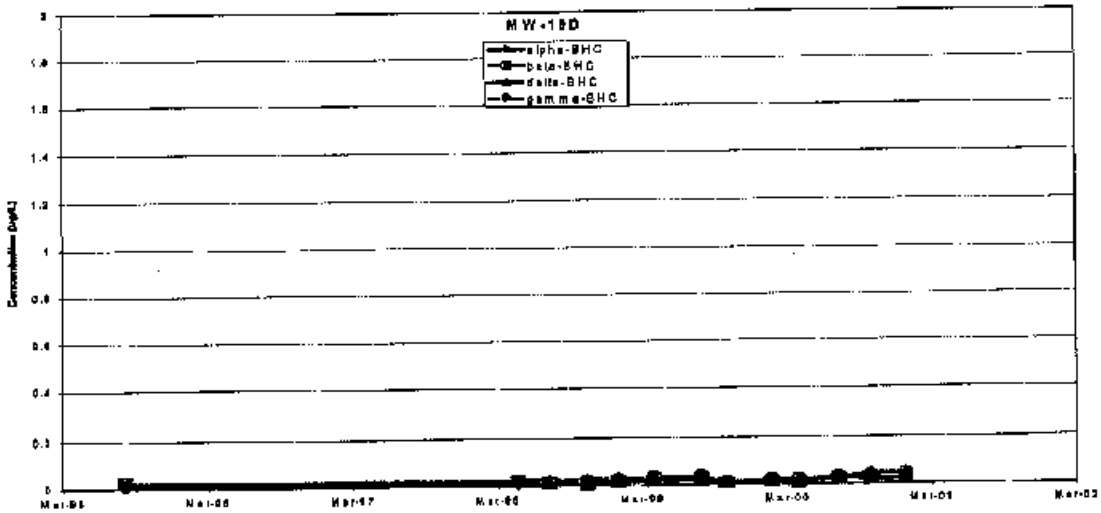

MW-10S
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (ug/L)
25
20
15
10
5
0
Mar-90
Mar-91
Mar-92
Mar-93
Mar-94
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02
Mar-03
Mar-04

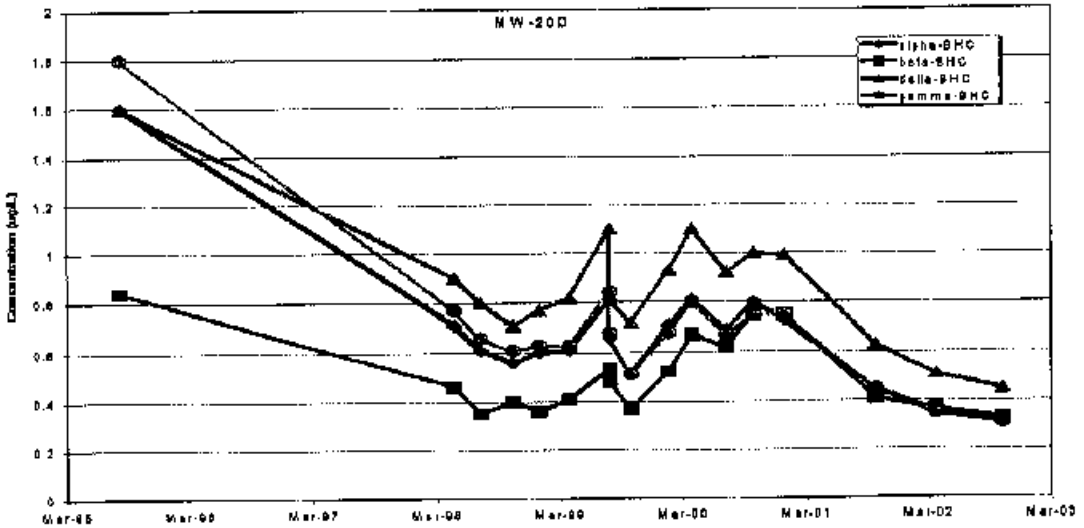
Attachment 5

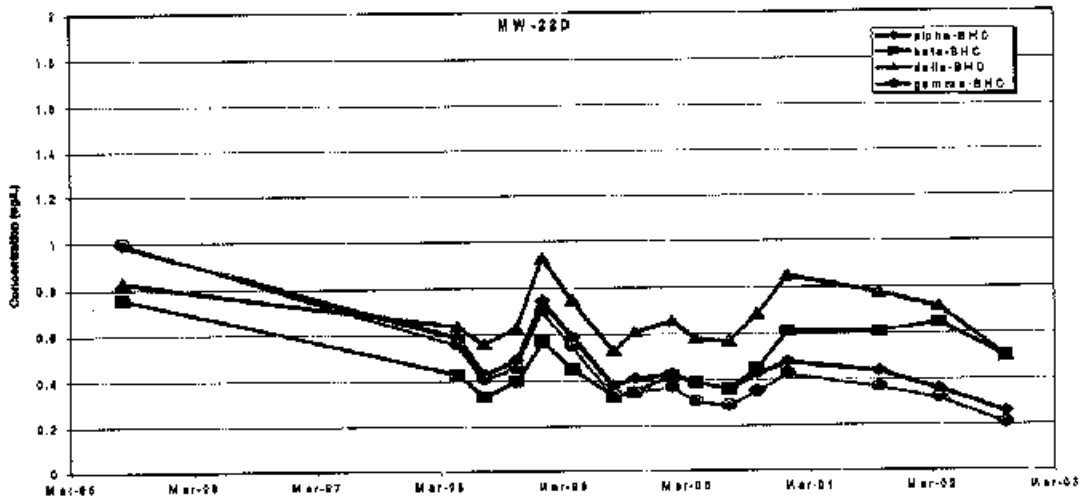
Upper Black Creek Aquifer Graphs

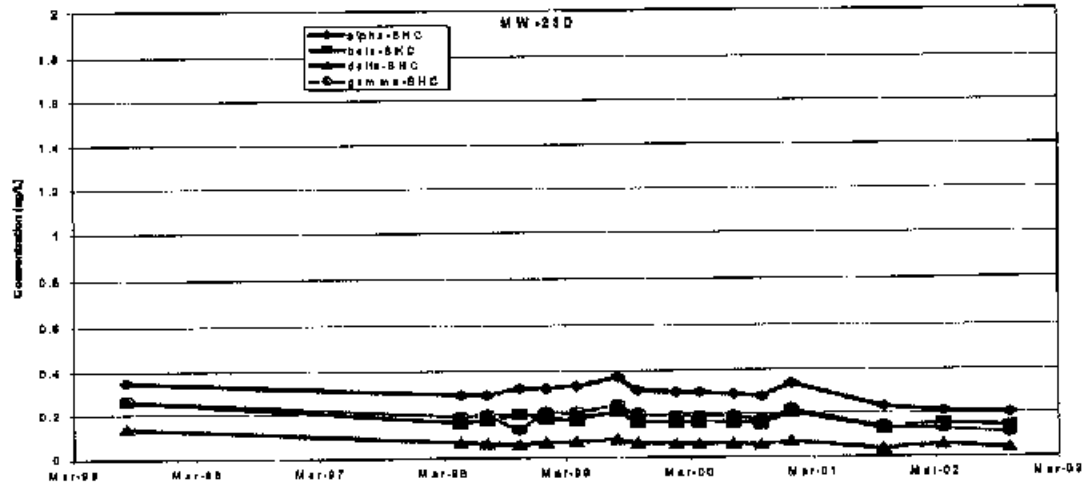

MW-11D
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (ug/L)
Jun-91
Jun-92
Jun-93
Jun-94
Jun-95
Jun-96
Jun-97
Jun-98
Jun-99
Jun-00
Jun-01
Jun-02

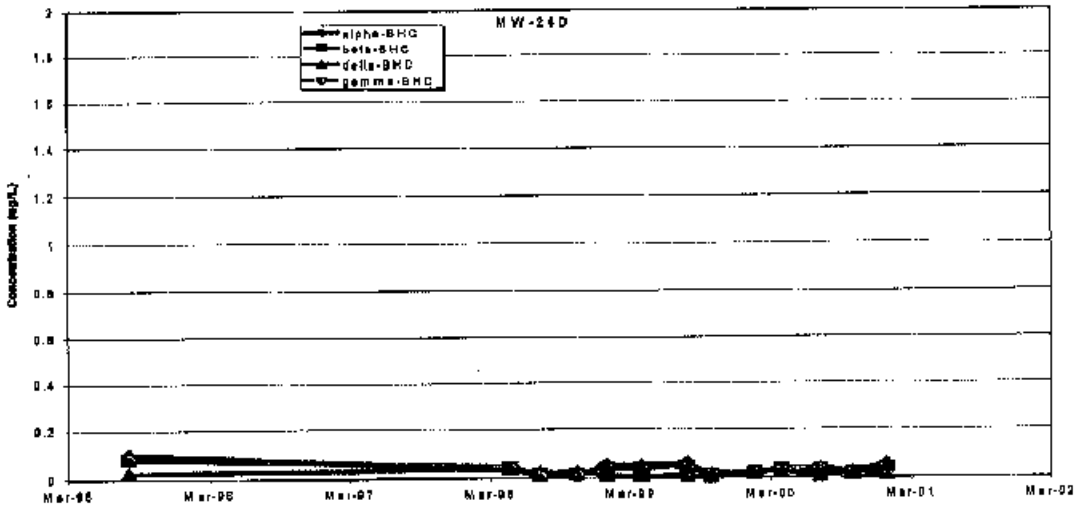

MW-18D
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (ug/L)
Mar-93
Mar-94
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02
Mar-03
Mar-04

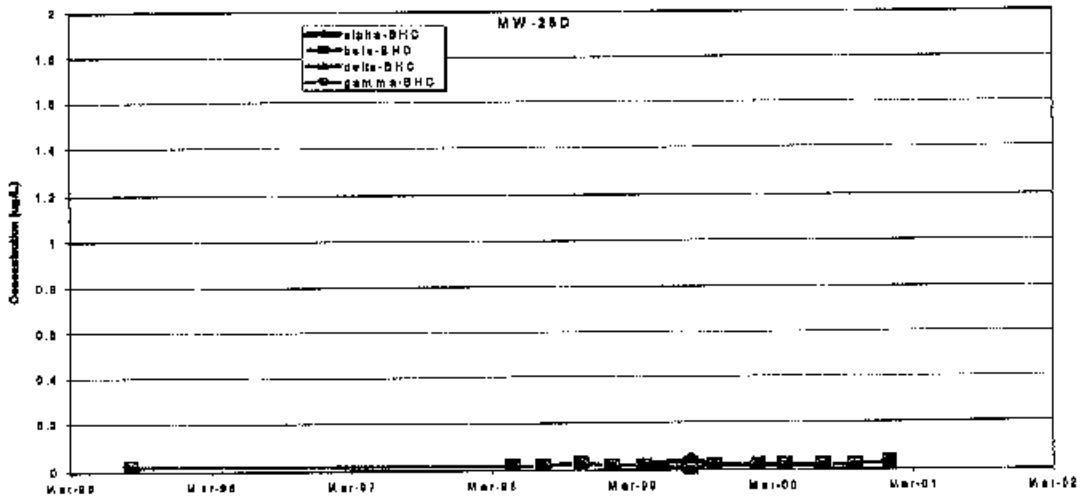

MW-19D
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (ug/L)
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02

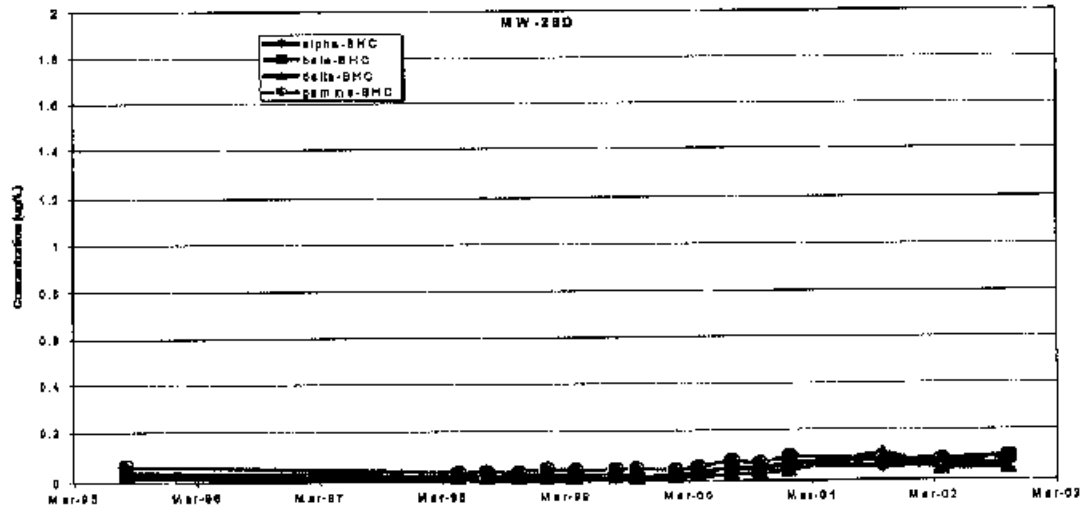

MW-20D
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (ug/L)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02
Mar-03

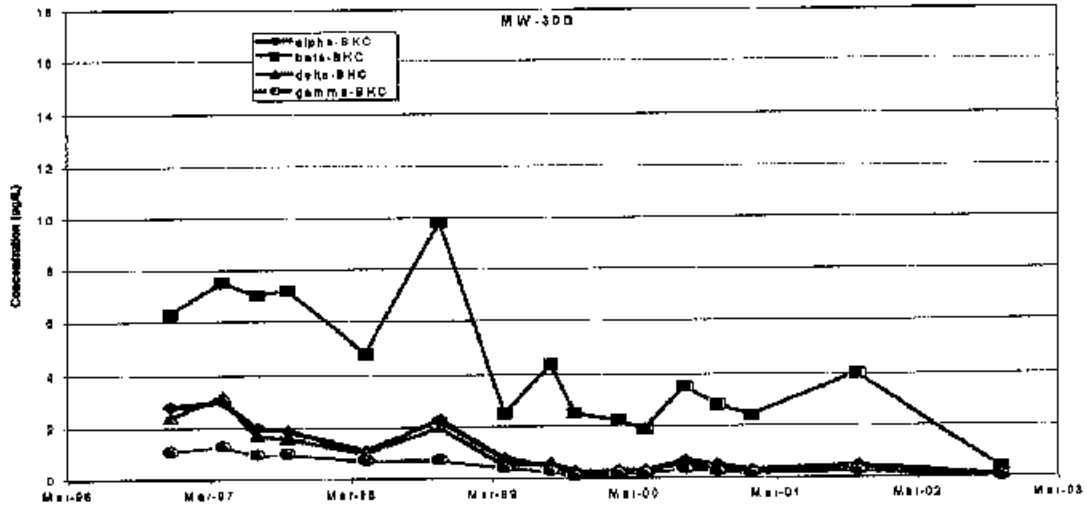

MW-22D
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (ug/L)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02
Mar-03

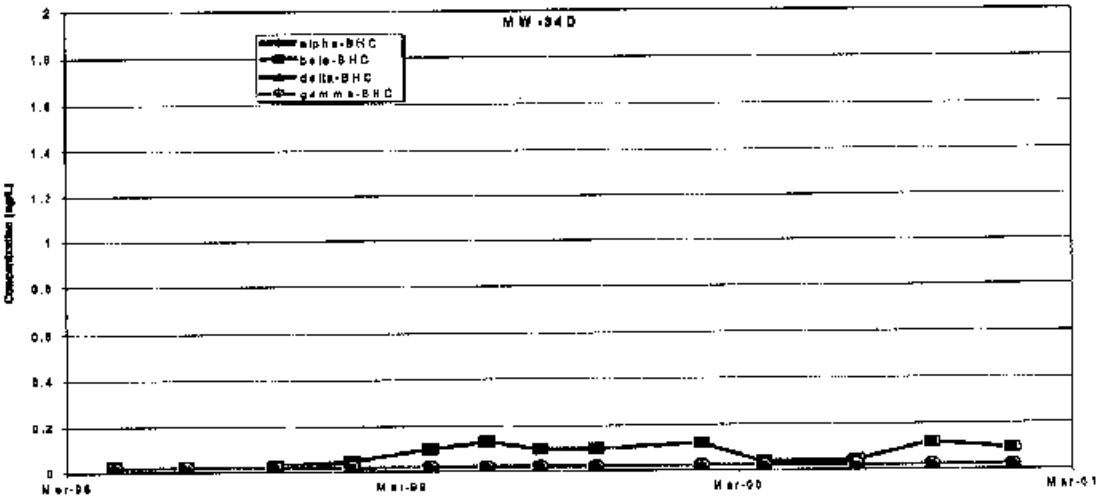

MW-23D
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (ug/L)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02
Mar-03

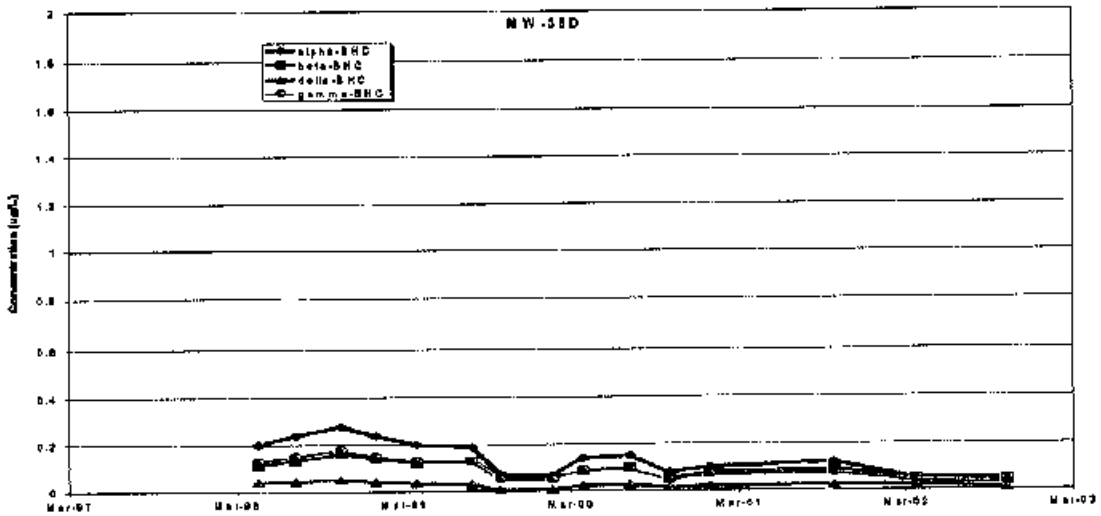

MW-24D
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (ug/L)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Mar-96
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02


MW-25D
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (ug/L)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Mar-96
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02


MW-28D
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (ug/L)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Mar-96
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02

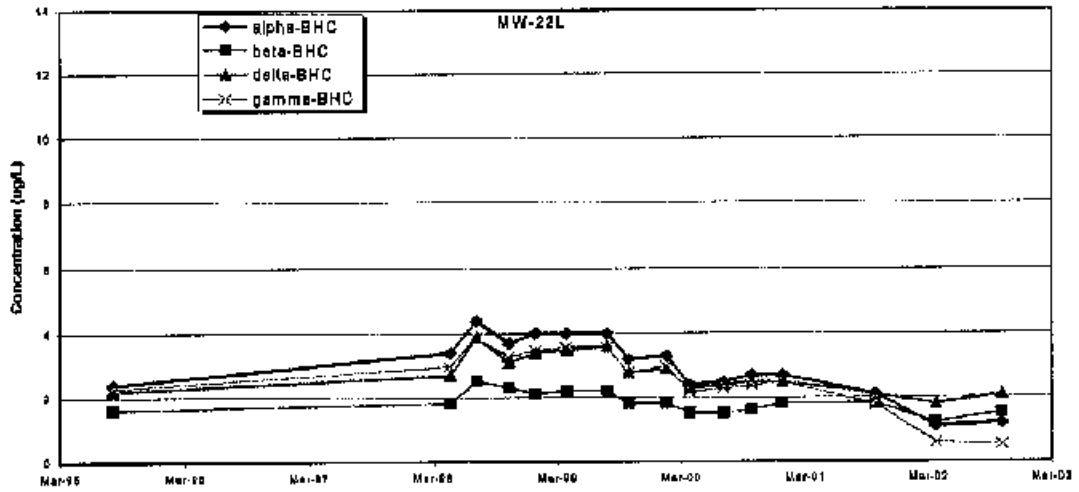

MW-30D
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (ug/L)
0
2
4
6
8
10
12
14
16
18
Mar-96
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02
Mar-03

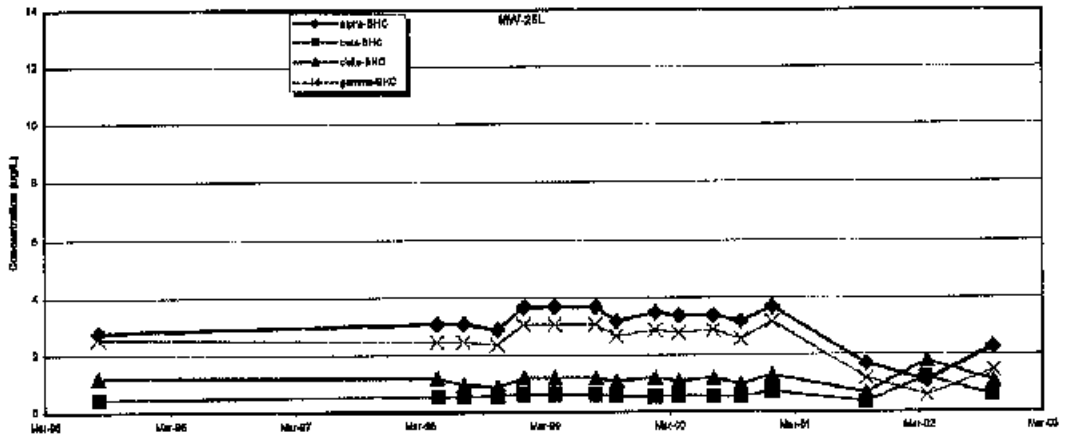

MW-34D
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (ug/L)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Mar-96
Mar-98
Mar-00
Mar-01

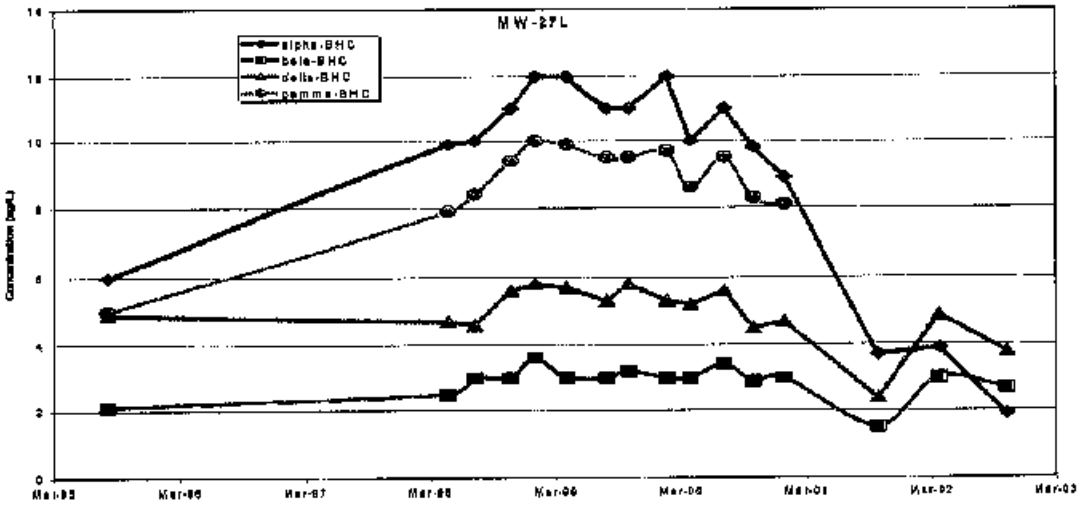

MW-38D
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (ug/L)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02
Mar-03

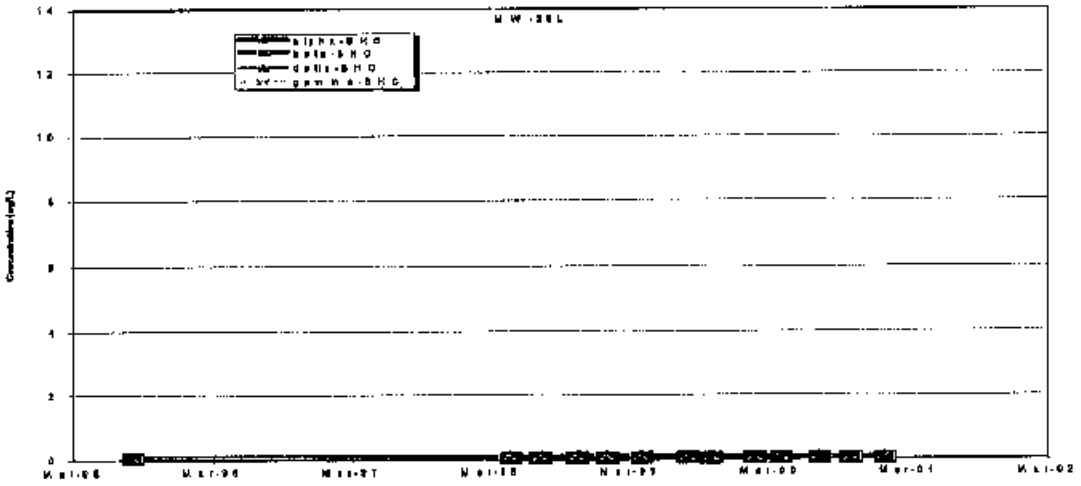
Attachment 6

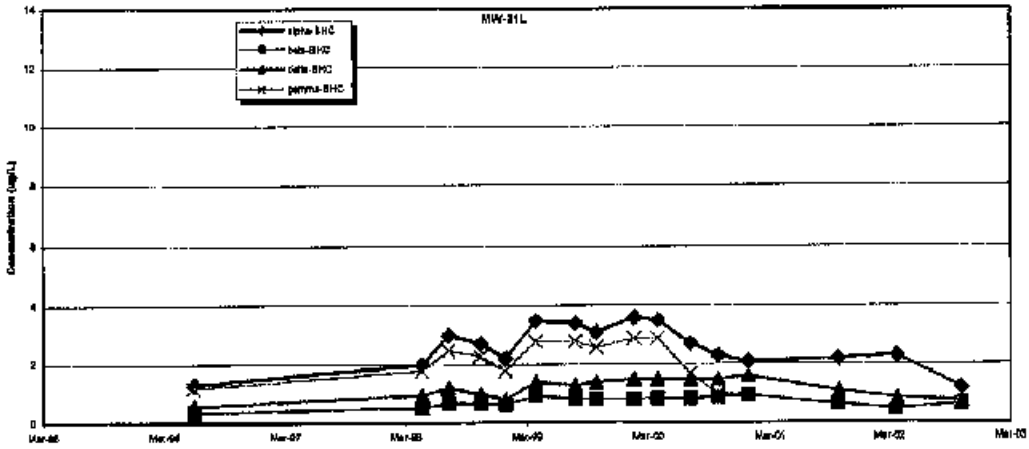
Lower Black Creek Aquifer Graphs

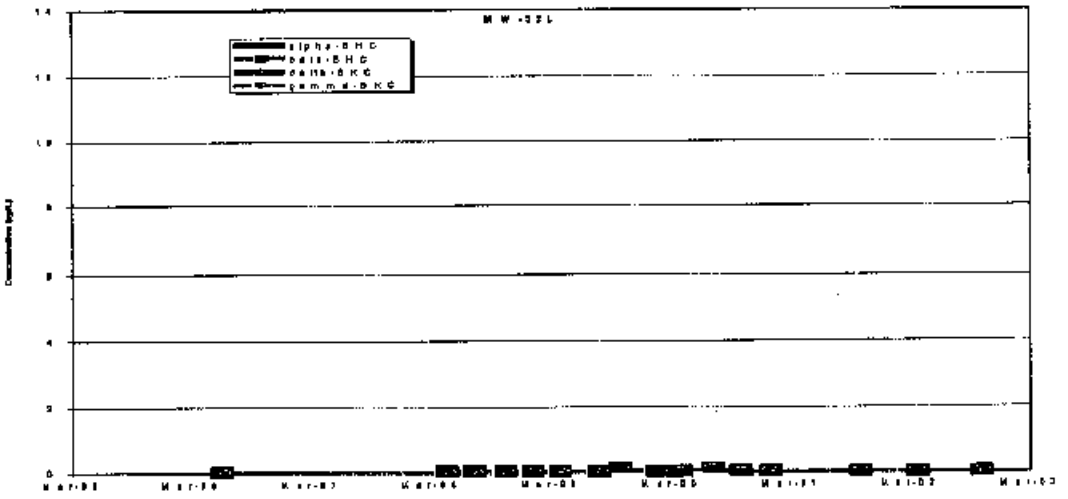

MW-22L
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (ug/L)
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02
Mar-03

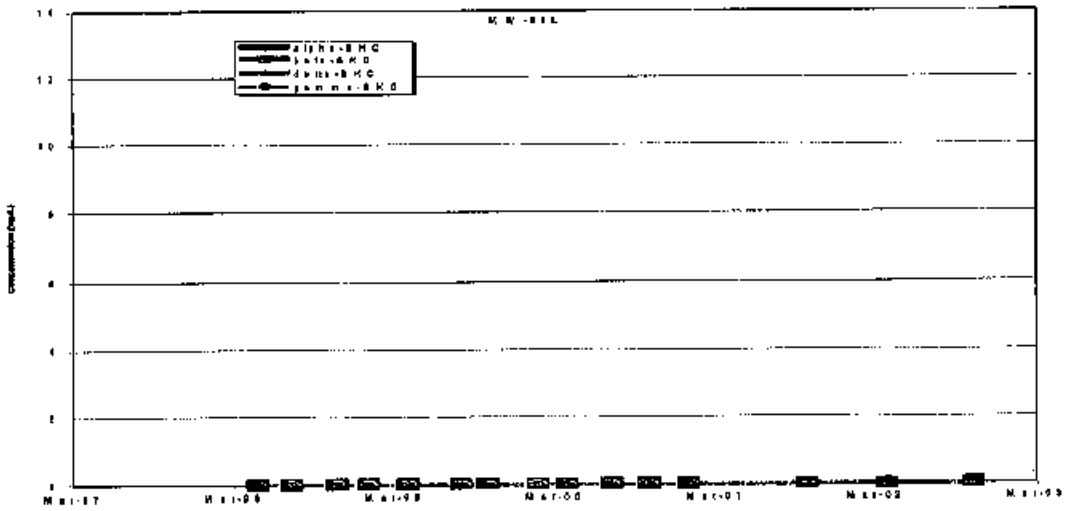

MW-26L
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC

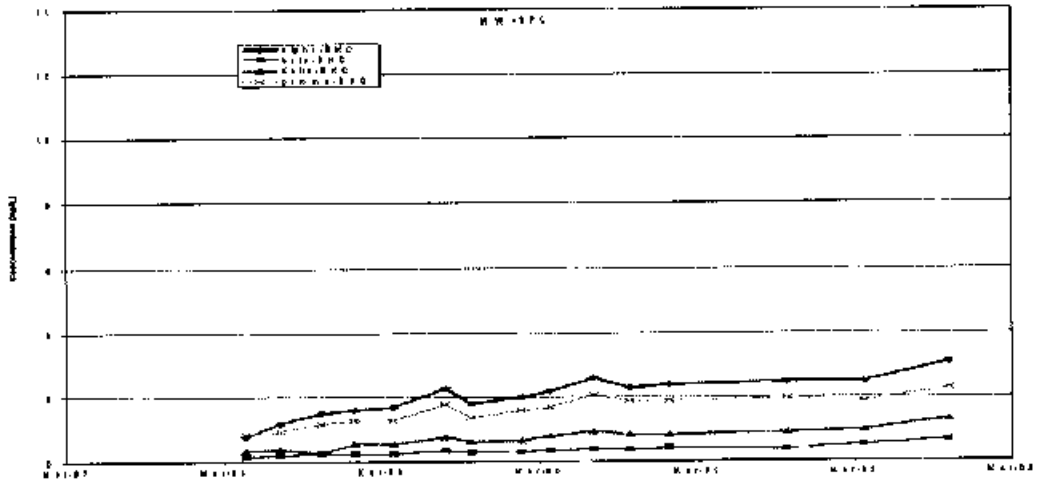

MW-27L
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (ug/L)
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02
Mar-03

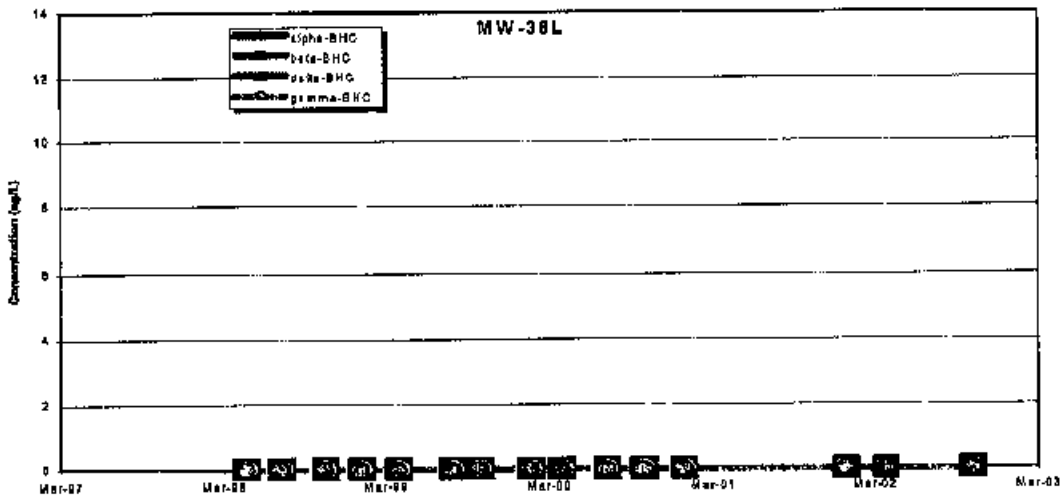


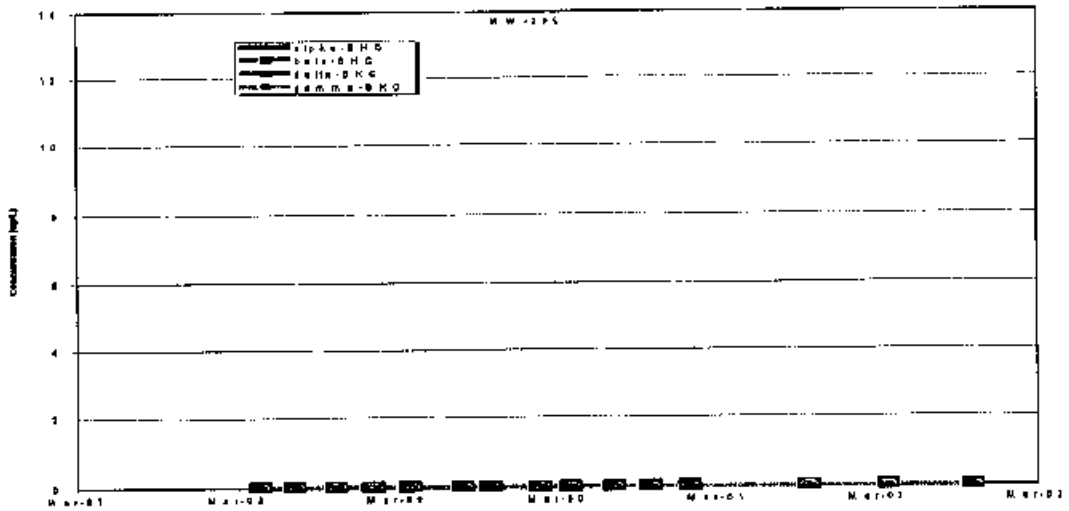

MW-31L
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC

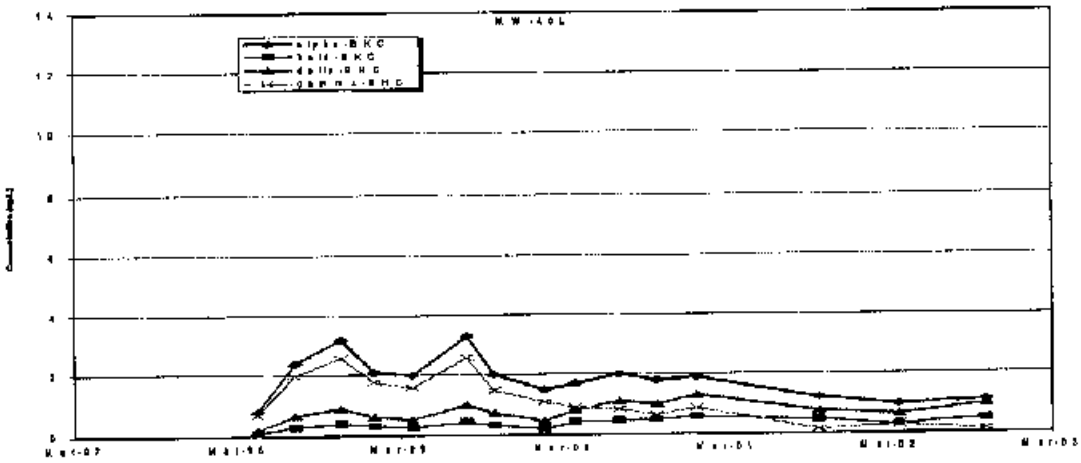






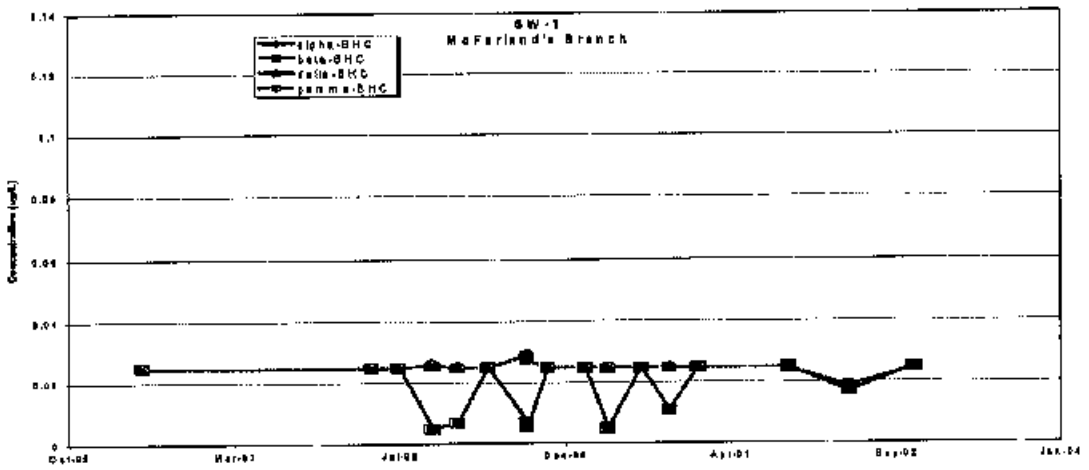

MW-38L
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (ug/L)
14
12
10
8
6
4
2
0
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02
Mar-03

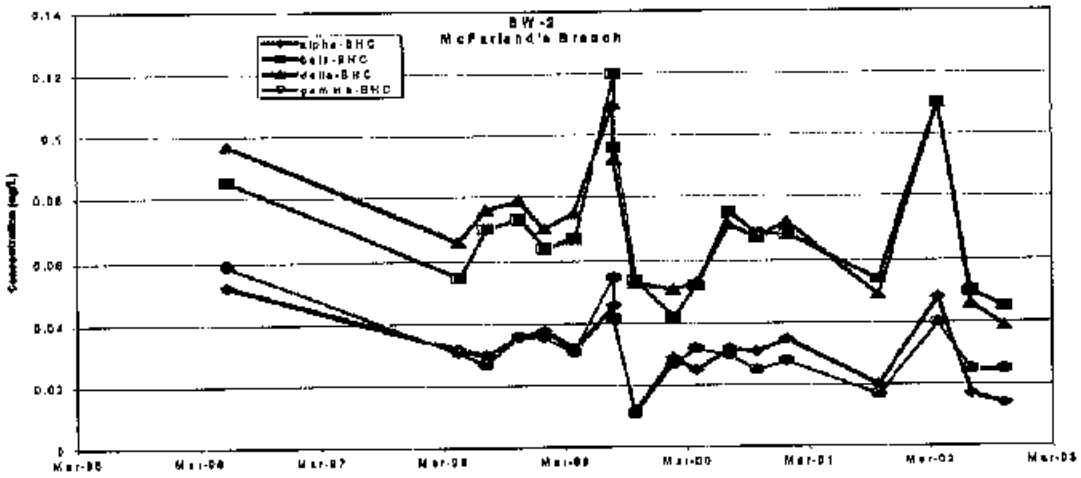


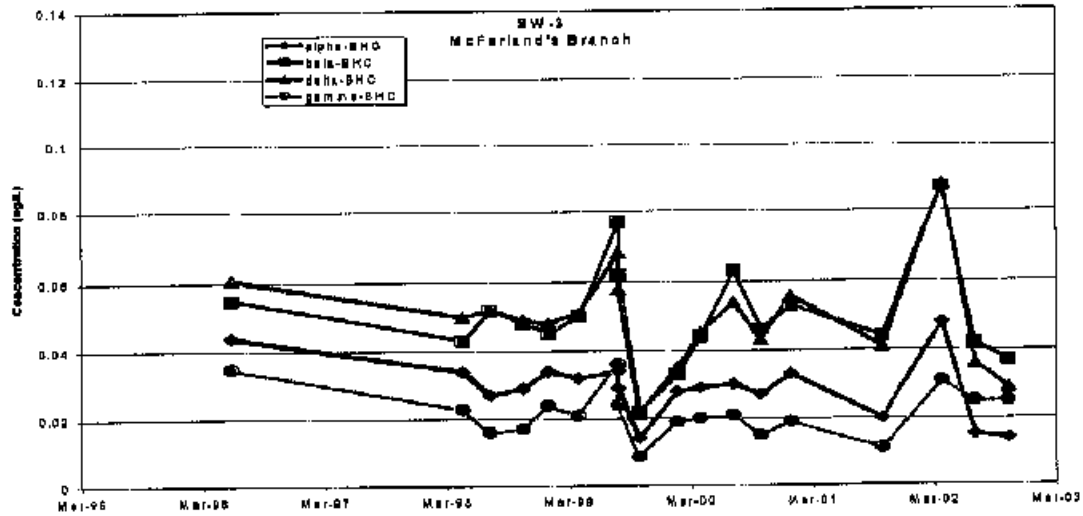


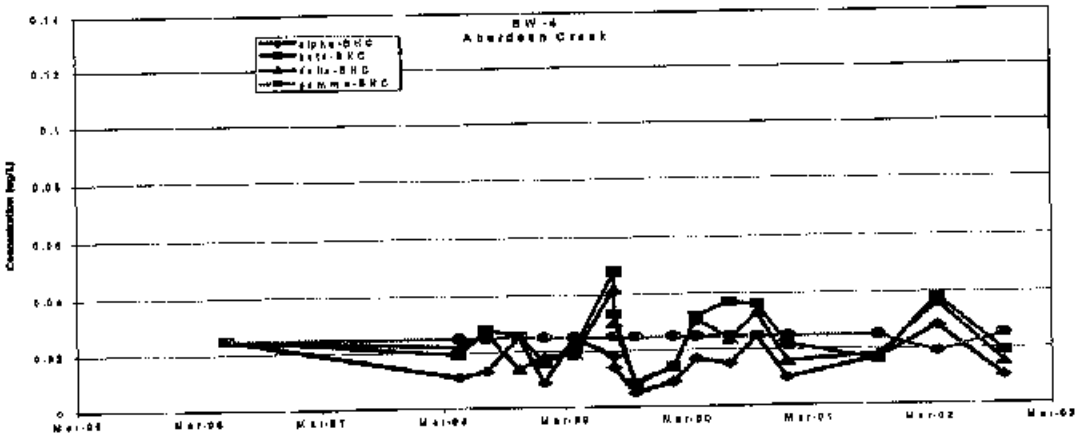
Attachment 7

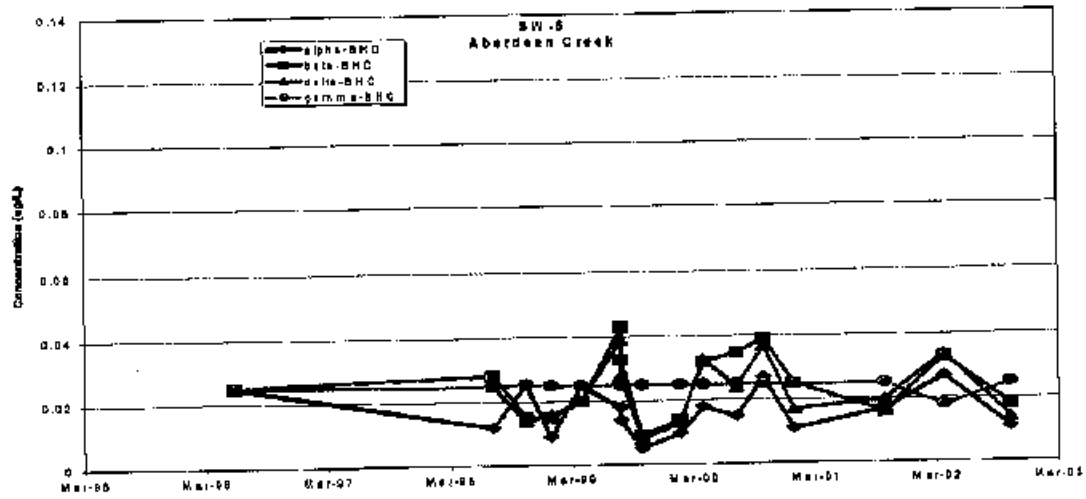
Surface Water Sampling Graphs

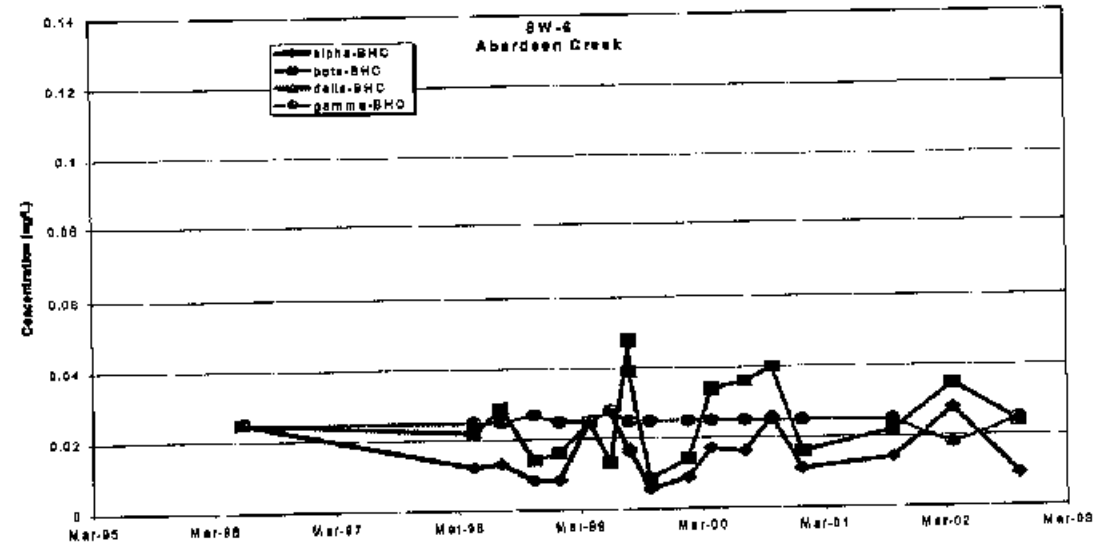

SW-1
McFarland's Branch
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC

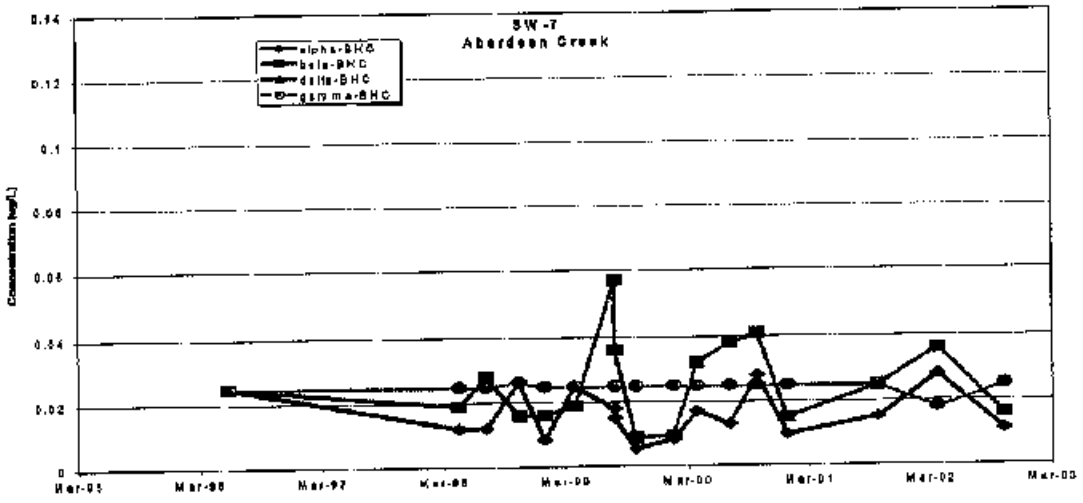

SW-2
McFarland's Branch
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC

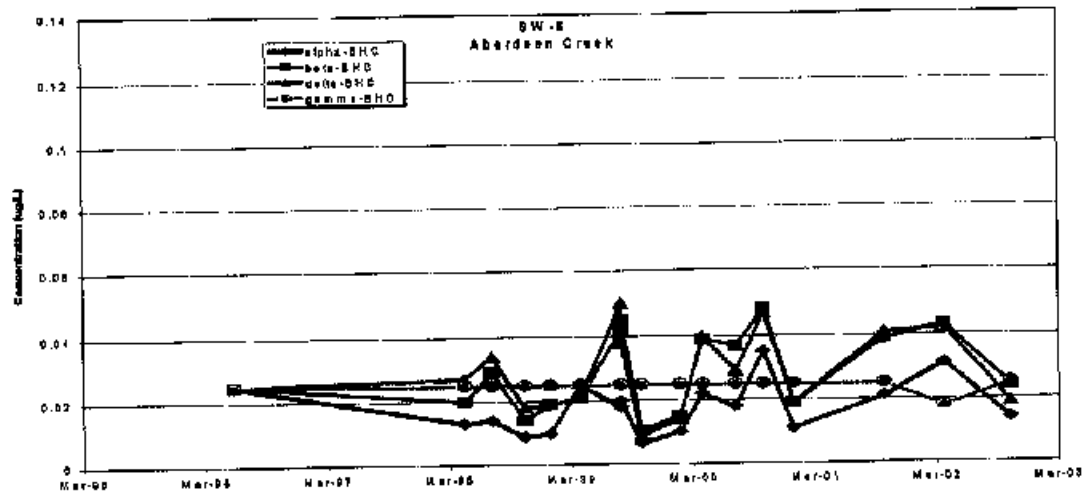

SW-3
McFarland's Branch
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC

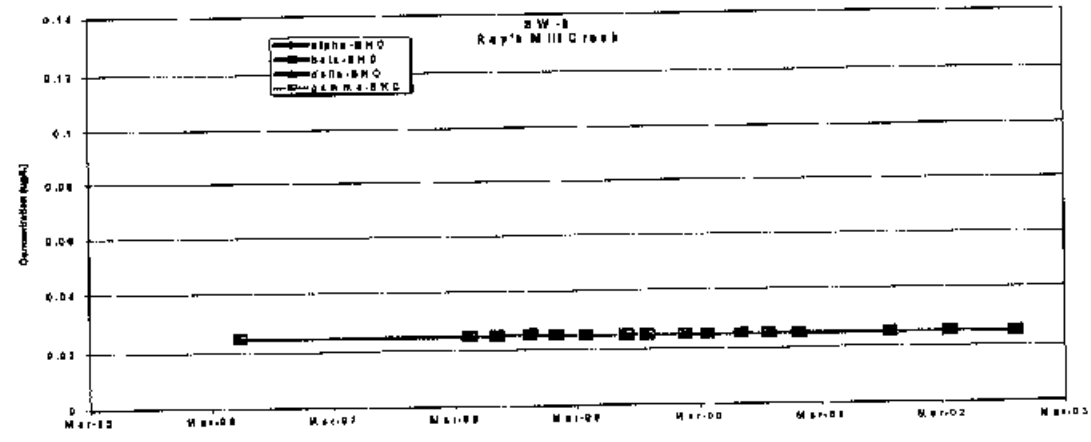

SW-4
Aberdeen Creek
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (mg/L)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02
Mar-03

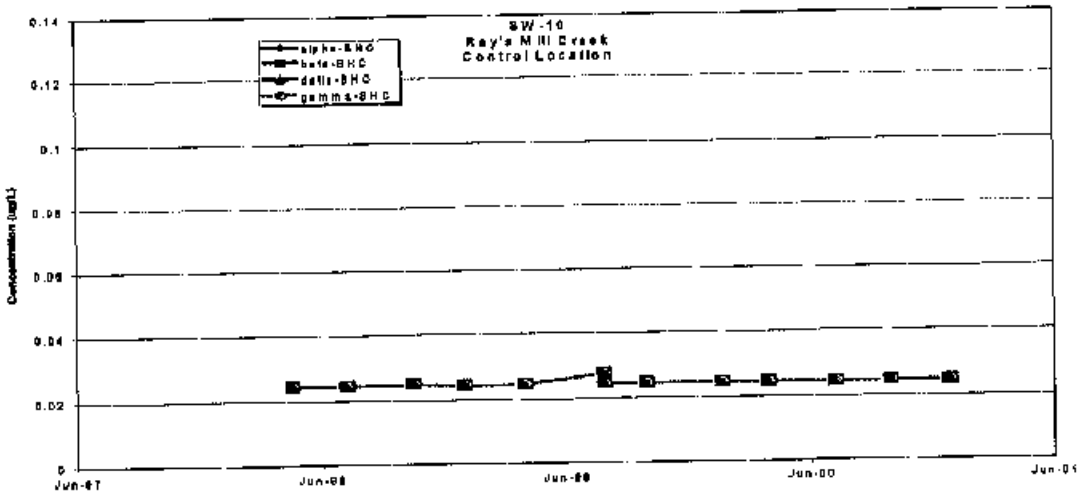

SW-5
Aberdeen Creek
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (ug/L)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02
Mar-03

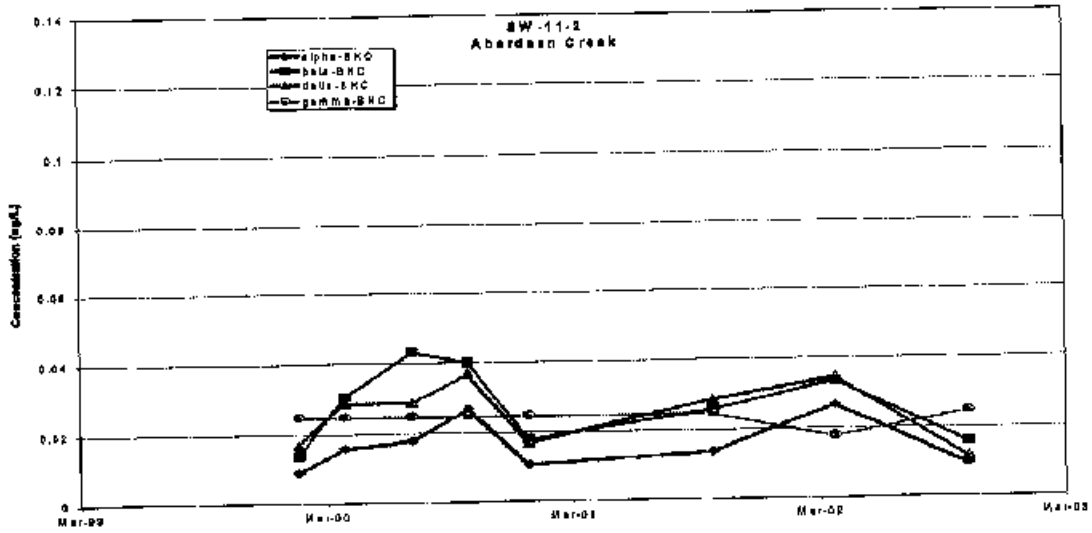

SW-6
Aberdeen Creek
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (mg/L)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02
Mar-03


SW-7
Aberdeen Creek
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (ug/L)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02
Mar-03


SW-8
Aberdeen Creek
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (ug/L)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02
Mar-03


SW-9
Ray's Mill Creek
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (ug/L)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02
Mar-03


SW-10
Ray's Mill Creek
Control Location
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (ug/L)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Jun-97
Jun-98
Jun-99
Jun-00
Jun-01


SW-11-2
Aberdeen Creek
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC
Concentration (ug/L)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Mar-99
Mar-00
Mar-01
Mar-02
Mar-03